Department of Science and Agriculture,

BARBADOS.

AGRICULTURAL JOURNAL

Vol. 1 No. 2. **April 1932.**

ADVOCATE CO., LTD.,—Printers & Bookbinders to the Government of Barbados

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DEPARTMENT OF SCIENCE AND AGRICULTURE.

SECTION I.—STAFF.

Director of Science and Agriculture.	R. W. R. Miller, B.A., (Camb). A.I.C., Dip. Agric. (Cantab).
Assistant Director	C. C. Skeete, B.A., (Cantab).
Geneticist	A. E. S. McIntosh, B.Sc., Ph.D., (Edin).
Agricultural Chemist	S. J. Saint, M.Sc., Ph.D. (London) F.I.C.
Assistant to Professor of Chemistry	T. A. E. Barker, B.Sc., (London).
Lecturer in Natural and Agricultural Sciences	W. A. McD. Paterson,
Entomologist	R. W. E. Tucker, M.A., (Cantab). B.Ed., (Capetown).
Veterinary Officer	C. P. Stoute, M.D.V., (Acting).
Chief Analytical Assistant	C. A. Coppin, B.A.Sc., (Toronto).
Plant Diseases Inspector	D. R. D. Wiles, D.I.C.T.A.
Chief Clerk	H. O. Ramsey.
Second Clerk	G. D. Ramsey.
Third Clerk	C. G. Humphrey.
Fourth Clerk	B. G. Barrow.
First Field Assistant	C. B. Foster.
Second Field Assistant	H. E. Ward.
Third Field Assistant	C. C. Corbin.
Fourth Field Assistant	F. E. Bynoe.
Analytical Assistant	H. A. Jones.
„ „	C. St. A. Alleyne.
„ „	L. A. Hall.
Botanical Assistant	L. H. Atkinson.
Foreman in charge of Nurseries ..	S. A. Eastmond.

Mr. S. J. Saint resumed duty after vacation leave on November 22nd.

Dr. A. E. S. McIntosh resumed duty after vacation leave on October 17th.

Mr. Saint and Dr. McIntosh, while on vacation leave, attended the Imperial Conference of Sugar Research Specialists held in London in July, 1931.

Mr. W. A. McD. Paterson was appointed Lecturer in Natural and Agricultural Sciences on October 19th and assumed duty on October 30th.

SECTION II.—BOARD OF AGRICULTURE.

The members of the Board of Agriculture, appointed for the Legislative Session, 1931—32, were as follows:—

The Honourable G. L. Pile, B.A., M.L.C., Chairman.
" " W. B. H. Massiah, M.A., M.D., C.M., M.L.C.
S. C. Thorne, Esq., M.C.P.
G. C. Mahon, Esq., M.C.P.
H. Alleyne, Esq., M.C.P.
E. S. Robinson, Esq., M.C.P.
J. D. Chandler, Esq., M.C.P.
H. A. Arthur, Esq., M.C.P.

The Director of Agriculture is an *ex officio* member of the Board.

The Hon. G. L. Pile resigned his seat on the Board on April 17th, 1931, and The Honourable S. C. Thorne was elected Chairman while Mr. G. D. L. Pile was appointed to fill the vacancy.

SECTION III.—EXPENDITURE AND REVENUE.

EXPENDITURE.

Personal Emoluments	£ 8,519	8	0
Overtime Allowance	4	10	0
Travelling Allowances	989	8	2
Exhibition	142	7	6
Appointment Expenses of Scientific Officers	34	15	0
Expenses in Control of Sugar Cane Mosaic Disease	1,797	6	7
Expenses in Control of Pink Bollworm of Cotton. (Salaries of Sub-Inspectors of Plant Diseases)	473	7	7
Experiment Stations and Botanic Station	2,226	10	0
Chemical Laboratory	831	8	7
Entomology	345	0	7
Sugar Polarization Laboratory	715	0	0
Unforeseen Contingencies	174	3	2
Sundries	349	11	0
Expenses in connection with duties of Veterinary Officer	3	11	0
Imvrovement of Garrison Savannah	78	13	0
Seed Distribution	206	1	3
	£16,891	4	5

REVENUE.

Sale of Ornamental plants	£ 19	16	6
Sale of Produce from land leased to Department	37	4	5
Sale of Cane Plants under Mosaic Disease Eradication Act	87	10	0
Fees for analysis of Sugar and Molasses	1,269	0	0
Fees for analysis of Miscellaneous Samples	101	12	0
Fees for Fumigation of Schooners etc., ...	26	8	3
	£ 1,541	11	2

SECTION IV.—PLANT INTRODUCTION, DISTRIBUTION AND INDENTIFICATION.

The importation of seeds of various ornamental flowering trees and shrubs was continued during the year.

Importation of seeds and tubers of economic plants is mentioned elsewhere.

The distribution of plants during the year was as follows:—

(a) Ornamental flowering trees	9
(b) Ornamental foliage trees	498
(c) Other ornamental plants	330
(d) Fruit trees	125
(e) Arbor Day free distribution	11,216
(f) Palms	63

The necessity for exercising the utmost economy combined with the fact that the free Arbor Day distribution has more than doubled itself within the last two years has necessitated a new basis for this year's distribution. Twelve ornamental plants will be provided free of charge and for additional deliveries up to one hundred a charge of two cents only will be made.

SECTION V.—GENERAL COMMENT.

NOTES ON THE SUGAR INDUSTRY.

In contrast with the severe drought of 1930, the year 1931 was one of heavy rainfall. The result of such favourable treatment in respect of the all important factor "rainfall" on the sugar cane crop was the growth of a crop of consistently heavy tonnage throughout the Island.

The rainfall during the planting season of 1930 was sufficient for good germination and consequently a "good spring" was general. But, the inadequate reserve of soil moisture, the result of the previous dry year, was soon

reflected in a gradual dying of many young plant-cane stools during the first few months or normal dry season of 1931.

Certain local areas were favoured with early effective showers in April, but the greater portion of the black soils and portions of the red soils suffered severely and in these areas a considerable percentage of the plant cane crop had already died when the first effective rains fell at the end of May.

The ratoon canes in the black soil areas, with their poorly developed stools of the previous season, were also seriously handicapped by the abnormally dry conditions, and, in general, never regained normal standard in spite of the adequate moisture from June onwards.

Adequate, persistent and occasionally excessive rain in local areas fell from June to November, by which time a crop of heavy tonnage was established. The dry December had apparently little effect on the crop, and any decline in available moisture caused thereby was soon compensated for by frequent showers in January 1932.

There was a further reduction in the area planted in the variety Ba. 11569 owing to the spread of gummosis during 1930 and to the knowledge that this variety was highly susceptible to the leaf symptoms of the disease. The variety B. 726 was extensively planted in its place, and responded very satisfactorily to the favourable rainfall conditions of the latter half of 1931.

In the highlands, B.H. 10 (12) continued to be the most extensively planted variety, but is now compelled to share the position of foremost yielder with B. 726.

The varieties B. 891 and B. 374 were planted in limited areas, recommended by this Department on account of their resistance to gummosis.

GENERAL CONDITION OF AGRICULTURE IN BARBADOS.

The sugar industry in Barbados in common with the rest of the civilised world continues to suffer from the effects of over-production—but while the chronic accumulations of surplus stocks have necessitated other sugar-producing countries to re-organise their production methods so as to decrease costs these avenues of economy have not been available to the average Barbados planter.

While other producers have reduced their labour bill by mechanising their cultural methods the necessity for finding employment for the huge population has limited the local planter's economies in the main to reducing the money spent on renewals, upkeep of roads, buildings, etc. Such economies can only prove a temporary expedient and will undoubtedly prove expensive in the long run.

The population of the Colony has outgrown itself to such an extent that in a more prosperous era unless some new outlet such as an attractive scheme

were acquired and a manager appointed and shipments of sweet potatoes, yams and eddoes made to British Guiana and Curacao. Unfortunately, this trade proved unremunerative owing to the heavy import duty into British Guiana and the very considerable marketing charges there, and it is considered that until such time as the Demerara government may be able to provide facilities for this class of provisions any attempts to dispose of our surplus ground produce in that direction can only result in further losses.

In September, a retail store for this class of goods and for fruit and vegetables was opened in MacGregor Street and in spite of the most gloomy forebodings the business continues to develop a gradually increasing turnover.

Mistakes have been numerous but since January 1st, 1932 by a ruthless reduction of overhead charges the Association has limited its expenditure to its means.

The Association has overcome considerable difficulties in maintaining a balanced supply of the various vegetables. Occasionally a glut of one class of produce would be followed by even a greater period of scarcity but gradually production has been made more regular so that the Bridgetown housewife is tolerably certain of procuring her daily needs.

Whatever opinions may be held as to the usefulness of such an institution its most bitter opponents must admit that the volume of supply of vegetables and the reasonable prices at which they may be obtained has proved its value to the community as a whole.

In past times the larger planter has rightly regarded the production of the sugar cane as the only stable investment for his capital and considering the large army of labour which requires regular all the-year-round employment it is difficult to visualise any other crop which could replace sugar, but the conditions under which the smaller planter and most of the peasants conduct their holdings are much more suitable to the introduction of other crops to eke out the returns from any canes which may be produced.

It is this class of cultivator that the Co-operative Marketing Association aims to benefit and already more than three hundred peasants from the following twelve District Agricultral Societies are finding a regular market for their produce:—

NAME OF SOCIETY.	PARISH.
Arthur Seat	St. Thomas
Charnocks	Christ Church
Economic	St. George
Enterprise	Christ Church.
Hillaby	St. Andrew
Mt. Tabor	St. John
Porey Spring	St. Thomas
St. John's	St. John
St. Joseph's Church..	St. Joseph
Stewart's Hill	St. John
Sugar Hill	St. Joseph
Unity	St. James

More societies are in course of formation and there is every reason to suppose that this season will see a marked development of this class of peasant agriculture. For the formation of these societies the thanks of the community are mainly due to Mr. H. A. Arthur, M.C.P., who has used unlimited energy on their behalf.

District Agricultural Societies form an ideal medium for the introduction of better crops and better types of seed and for the improved agricultural education of the peasant farmer. Unfortunately up to the present the Department has been unable to provide an officer for this work but it is hoped that with better times such an appointment may be possible as without such an officer there is always the possibility that this movement may be indefinitely retarded.

The Association has been able by the importation of seed of strains recommended by the Department to provide its members at cost price with the best available planting material and the extra returns gained by superior seed have amply repaid the outlay.

During the last winter season the Association have exported to Canada 633 twenty pound cases of tomatoes and 170 crates of string beans. Up to the present, grading and packing, under the advice of the Department, have been carried out by the individual grower on his own holding and although uniformly good reports have been received from the consignees in Montreal on the packing and grading of the fruit it is obvious that this method of shipment is only a makeshift one.

Barbados has definitely shown that tomatoes of as good a quality, if not better than those produced by the other islands can be grown. The Canadian market has expressed itself as eager for large regular consignments next season, but without proper packing and pre-cooling accommodation under the direct supervision of Government and the Association it is impossible to consider any further development of this trade.

Although the Barbados Co-operative Produce Marketing Association may still have some considerable distance to travel before it is firmly established nevertheless the first season's working shows every justification for optimism.

CREDIT SOCIETIES.

Only two Credit Societies have so far been registered and of these only one has applied for and obtained loans for the improvement of their holdings.

While the sparse number of smallholders who have availed themselves of this means of financing their cultivation is regretted nevertheless it is considered that the present position is to be preferred to that obtaining in other Colonies where once the first enthusiastic vigour has spent itself it has been found that the vast majority of credit societies have been composed of members who, neither by disposition nor financial status, were fitted for this class of co-operation.

Facilities, however, must eventually be provided for the supervision of Credit Societies and for the proper agricultural education of the peasant cultivator. Every estate which is broken up and re-sold into small holdings under

present conditions represents so much lost capital to the Colony and there is no doubt that a sympathetic and efficient Agricultural Instructor would prove a very sound investment to Barbados.

SECTION VI.—ADMINISTRATIVE AND EXPERIMENTAL WORK.

(*a*) ADMINISTRATIVE.

Control of Pests and Diseases.

The presence of the Mosaic Disease of the Sugar Cane in the Island made it necessary to continue inspections throughout the sugar cane districts until the height of the canes prevented proper inspections.

The number of Mosaic infected holes found in certain areas during July and the early part of August, 1931, compelled certain areas to be added to the infected areas mentioned in the Annual Reports for the years 1927-28 and 1928-29. The new areas were as follows:—

(1) *In the parish of St. George.*

Newbury Plantation, Newbury tenantry, Sweet Bottom tenantry, also the area bounded on the North by Market Hill plantation, and on the East by Cottage and Grove plantations, on the South by Francia and Moonshine plantations and on the West by Locust Hall plantation.

(2) *In the parish of St. John.*

Sherbourne tenantry, Carters tenantry and Wakefield plantation.

The Corn Close Season was again proclaimed to include those areas mentioned in the Departmental Reports for the years 1927-28 and 1928-29, with the additional areas mentioned above, extending from the 16th December, 1931, to the 31st March, 1932. This year no difficulty was experienced in maintaining this close season, and therefore no prosecutions were necessary due to the occupiers carrying out the instructions of the Department's Officers in an efficient manner.

Cane plants which were free from mosaic infection were again supplied to occupiers in the Proclaimed Infected Areas (vide Annual Reports 1927-28 and 1928-29, and the areas mentioned above). Plants were distributed from the following centres:—

PARISH.	CENTRE.	VARIETY.
St. Michael.	Waterford pln.	B.891 & B.726.
St. James and St. Thomas	Ridgeway pln.	B.891 & B.726.
St. Peter	Warleigh pln.	B.891.
Christ Church.	Yorkshire pln.	B.891.
St. George.	Fisherpond pln.	B.891, B.726 & B.H.10(12).
St. John.	Lemon Arbor pln.	B.H.10 (12).

Plants were distributed at each centre under the supervision of an Inspector and in all approximately 612,600 plants were given out.

The plots of several occupiers in the proclaimed infected areas were inspected at the request of the occupier by an Officer of the Department and many occupiers were allowed to cut their plants from their own plots, certificates of approval being issued in the customary manner.

The inspection of the young crop commenced in mid-January 1932, and is being continued until the fields become impassable.

Parish of St. Michael.

The mosaic infection in certain of the large tenantries and small holdings still persists but to a lesser extent than heretofore. Again no diseased holes were found in the Belle tenantry and Welches for the period under review. The heaviest mosaic infection is to be found in Goodland tenantry, principally among the ratoons which the occupiers in that district persist in keeping. Many occupiers in the proclaimed infected area were allowed to cut their own plants after the spot had been inspected by an officer of the Department and so far Bush Hall and Bank Hall tenantries have remained fairly free from infection.

Parish of Christ Church.

The infection in the proclaimed infected areas of this parish continues to be very much on the decline and it is hoped that certain of these areas will be removed from the list by the time the planting season of 1932 arrives. The heaviest infection is to be found in the large tenantry of Lodge Road where the infected stools have been removed whenever found. There are still a few diseased holes to be found outside of the abovementioned area but these are scattered throughout the parish.

Parish of St. John.

The heavy mosaic infection found at certain estates and in tenantries compelled them to be included in the proclaimed infected areas in the island. Careful attention was paid to the selection of plants at planting time, the Inspector of the district being present at Wakefield plantation whenever plants were being cut. Inspection of the young crop at this place for the first time during 1932 showed only 35 infected holes in 32¾ acres of plant canes. It is, however, hoped that the infection will be considerably less in this parish due to the careful selection of plants as well as the supply of healthy plants to the tenantries through the Department.

Parish of St. Joseph.

The infection in this parish is confined to Sugar Hill tenantry where during the planting season plants were cut under the supervision of an Inspector. It is anticipated that, by constant rogueing of the diseased stools coupled with the abovementioned method, this tenantry will soon be free from any mosaic infection.

Parish of St. Lucy.

Checker Hall tenantry, the only area in this parish which had been included in the list of infected areas but which had been removed from that list in 1930, was again inspected and no diseased holes were found. Cane plants were, however, again cut under the supervision of an Inspector. The infection which was found in the eastern portion of the parish has not re-appeared and it is hoped, in the near future, that inspections in this parish will be curtailed.

Parish of St. Peter.

During the inspection of the infected areas in this parish, which include Farm tenantry, Battaleys plantation, Road View tenantry and Speightstown, very little infection was found. Cane plants were again distributed to these areas and up to the present time no diseased holes have been observed in the young crop in the infected area.

Parish of St. James.

Mosaic diseased holes of canes are still being observed in certain of the infected areas but to a lesser extent than heretofore. The heaviest infection is to be found in Payne's Bay tenantry and its surroundings. This district has already had one inspection of the new crop when only 21 infected holes were found. This result is due, no doubt, to the rogueing of diseased stools and the use of healthy cuttings at planting time. The infection in the other proclaimed infected areas is very much on the decline and at one place where the young crop has already been inspected only 35 diseased holes were found in 70 acres.

Parish of St. Thomas.

Healthy cane plants were again supplied to the Rock Hall district and for the period under review only 74 diseased holes were found, this infection being confined principally to the ratoons. The mosaic infection on the estates in this parish is very low with the exception of one estate on which 350 diseased holes were found, the majority of which were in one variety (B.891).

Parish of St. George.

Cane plants, free from mosaic infection were supplied, for the first time, to the tenantries in the infected areas in this parish and it is expected that by this means as well as the constant rogueing of diseased stools that the infection will be considerably lessened. It is with pleasure that I have to record that on one of the estates, which has been in the lists of proclaimed infected areas for the last two years, no disease holes were found during the first inspection.

All diseased stools which have been found by the inspectors during their visits have been removed and many occupiers who have now learnt the leaf symptoms of the disease have been rogueing their own plots.

To be able to effect a proper control of the mosaic disease careful attention must be paid to the selection of the fields from which it is desired to cut plants. These fields should be kept under constant observation from the time of

planting until the planting season arrives and should any infected holes be found they should be immediately removed. Plots similar to the above were inspected by an Officer of the Department prior to the cutting of the plants provided sufficient notice was given. During the year many owners and occupiers availed themselves of this service and it is hoped that in future years this valuable precautionary work may be even further increased.

The co-operation between the owners and occupiers and the Officers of the Department has been of a very cordial nature and every one has tried their best to assist the work of the Inspectors.

GUMMING DISEASE OF SUGAR CANE.

The leaf symptoms of the gumming disease of the sugar cane continued to make their appearance and the symptoms spread rapidly in fresh districts in the island. A survey of the island was made in September 1931 and below are two maps comparing and showing the areas where the leaf symptoms were found in 1930 and 1931.

To assist in the control of this disease, cane plants of the varieties B.891, B.755 and B.H.10(12) were distributed to the proclaimed infected areas under the Mosaic Disease Eradication Act as it had been observed that these varieties were less susceptible to the leaf symptoms of gumming.

Due to the spread of the leaf symptoms of the gumming disease of the sugar cane throughout the Island canes taken from a field at Dodds, St. Philip, which had been originally planted with Ba. 11569 cuttings obtained from holes which shewed leaf symptoms of the disease, were cut up in sections of 8″ to 12″ long, these sections being taken from different quarters of the cane. The sections so obtained were suspended in kerosene tins over a surface of water and covered with wet sugar bags. The first samples taken and treated as above were set at 9 a.m. on the 7th October 1931 and when examined at 3 p.m. on the same day, the gummy exudation peculiar to the gumming disease of the sugar cane was observed.

Up to the time of writing sugar factories in the parishes where there has been a large area showing the leaf symptoms of the gumming disease report that they have had very little trouble with the manufacture of sugar.

Proper attention should, however, be paid at the planting season to the selection of the fields from which the cuttings are going to be taken as well as varieties should be used which have been proved to be fairly resistant to the disease.

The situation with regard to recommending definite varieties of cane for planting has been seriously affected by gumming disease. There is no doubt that certain varieties such as B.726 and B.891 may on occasion develop gum in the stem, and the fact that the Ba. 11569 variety may show definite gumming but in insufficient quantity to cause trouble in the factory in the manufacture of sugar may be due to the disease being of only a mild type or on the other hand it may be that the Ba. 11569 is only mildy susceptible to any form of the

disease. The possibility of this variety eventually being badly attacked must also be considered and this is especially unfortunate as it has proved itself of great value in certain parts of the island.

INSPECTIONS UNDER THE COTTON DISEASES PREVENTION ACT 1928.

The low price which cotton growers obtained for their 1930—31 crop and the non-sale of a large proportion of the lint shipped at the time the 1931—32 crop was to be planted considerably lowered the acreage, only 1455 acres being planted which is made up as follows:

(a)	Plantations	707¼ acres.
(b)	Peasants	747¾ acres.

The Peasant Cotton Plot Competition which had been instituted last year for the first time was again held. The Island, however, was divided into two districts so as to assist the judging as previously it had been found very difficult to award prizes using the Island as a whole due to the different times of planting.

District 1 included the parishes of St. Lucy, St. Peter, and St. James.

District 2 included the parishes of St. Philip and Christ Church.

Judging took place during the last week of November 1931 and 83 plots were entered for the competition from the following parishes:

St. Lucy	57
St. Philip	13
Christ Church	13

It is pleasing to record that the first prize in District 1 was awarded to a plot whose owner was also one of the prize-winners in the previous year's competition.

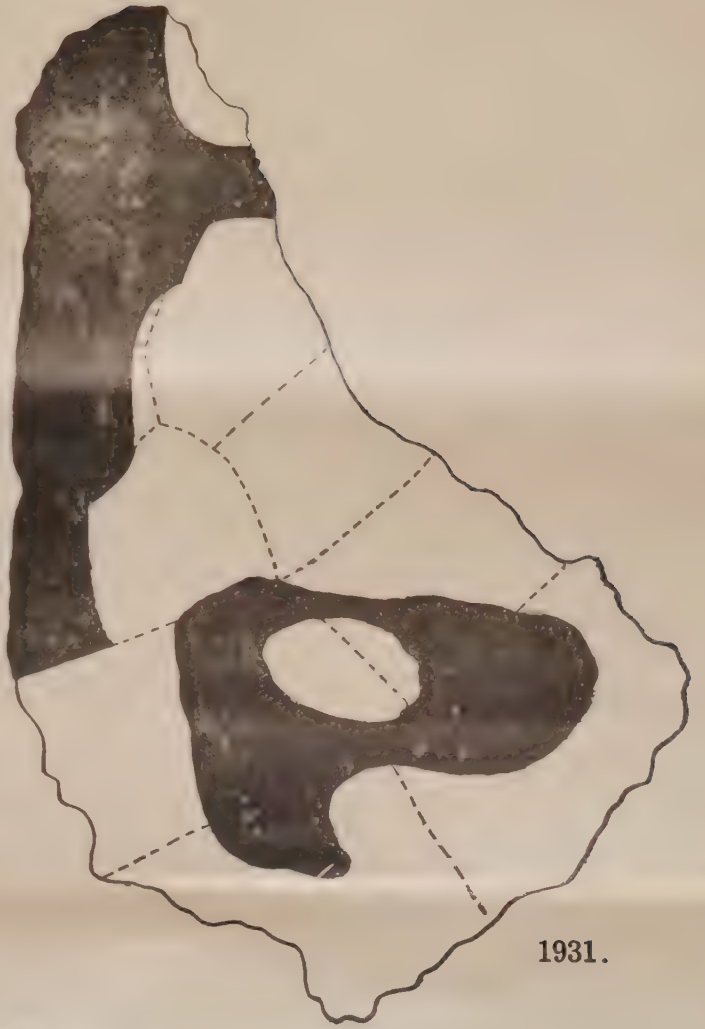
The inspection of the cotton plots was commenced as soon as the trees began to boll so as to find out the time of attack of the pink bollworm. Several thousand bolls were examined in the field and on the 13th January 1932 pink bollworm punctures were observed for the first time during the growing season.

In response to a circular to cotton growers asking them to forward bolls to the office for inspection, 995 bolls were received out of which only nine were found to be punctured. This does not mean that the pink bollworm has not spread because as will be seen from the attached map of the island it has been found in all of the principal cotton growing districts.

The Cotton Close Season was again fixed for 1932 to extend from the 1st May 1932 until the 31st August 1932 throughout the Island with the exception of certain areas in the parishes of St. Lucy and St. Philip when the close season ends on the 15th of August.

Gumming Disease of Sugar Cane in Barbados

1929—30.



1931.

The blackened areas show those parts of the island in which the disease is prevalent.

MAP SHOWING LOCALITIES WHERE THE PINK BOLLWORM OF COTTON WAS FOUND DURING 1931—1932.

○ found in January, 1932.

◐ found in February, 1932.

◒ found in March, 1932.

An Okra Close Season was again fixed to extend from the 15th April to the 15th May 1932. Permits were granted to growers to keep okra plants provided the fruit was only used as a vegetable.

For the period under review 3,030 bags of imported cotton seed was disinfected in the Simon's heater under the supervision of an Inspector and three ships fumigated with Zyklon B.

MISCELLANEOUS INSPECTIONS.

For the period under review the following privately imported plants were examined:—

Four hundred and three packages of bulbs, rose trees carnation plants, vegetable and flower garden seeds.	Examined and passed.
One package blackpepper cuttings	do.
Two packages of bulbs	do.
One package pineapple suckers	do.
One package coconut seed	do.
Five growing coconuts	do.
One Plum tree	do.
Three ferns	All soil removed and roots washed.
One pear plant	do.
Two palms	do.
Twenty-four citrus plants	do.
Six boxes Flowering plants	do.
Fifty-eight mango plants	do.
Six growing coconuts	Destroyed
One box coconut seed	do.
One Fern	do.

VETERINARY SERVICE.

The functions of the veterinary service during the year were directed against the introduction of disease and inspection of all animals imported into the Island, the rendering of medical and surgical treatment for the Police horses and mules and other Government stock at the Government Industrial School and the Mental Hospital Dairy and the inspection of meat at the Bridgetown Slaughterhouse.

Rules were drafted and submitted at the request of the Commissioners of Health for the parish of St. Michael for the registration of diseases, tuberculin testing of cows and sanitary control.

A Registration of Veterinary Surgeons Act was passed late in the year and will come into operation almost immediately.

The landing of dogs and cats in Barbados from Trinidad was prohibited.

GOVERNMENT ANALYST.

The usual analyses of food and drugs were carried out during the year and

altogether a total of 1,156 samples were examined for the various Government Departments and the general public. This represents an increase of 150 samples over those of 1930. They comprised:—

(a) Police Department.

Viscera and examination for poisons	32
Food and drugs	191
Rum	36
Coins and counterfeiting exhibits	24
	283

Six samples of viscera were found to contain atropine probably derived from tincture of belladonna. A liquid submitted in connection with this viscera was found to consist of this tincture.

Five samples of viscera contained traces of arsenic: this arsenic was apparently derived from medicine which deceased had taken. The prescription included Fowler's solution.

One sample of a suspected liquid was found to contain a quantity of laundry blue and powdered glass.

Two samples of food contained gunpowder in large amount.

From a sample of suspected drinking water 11½ grains of white arsenic were separated.

One sample of sugar contained green particles of copper arsenite.

Three powders submitted were found to contain mercury as white precipitate.

In seven samples of suspected food or drink no poison or harmful ingredient was found.

Under the Food and Drugs Act 169 milks and 22 flours were examined. These numbers show an increase of 40 per cent. over those of 1930. Thirty per cent. of samples of milk contained added water. The percentages of adulteration with added water for the last five years are:

Year.	1927	1928	1929	1930	1931
No. of samples analysed ..	331	240	245	121	169
% Adulterated ..	19.0	17.1	11.5	17.3	30.0

Those for 1931 show the highest adulteration since figures are available. The added water varied from 5 per cent. to a maximum of 34.1 per cent. and indicates the need for more drastic action against the vendors of adulterated

milk. Three samples were found deficient in fat. It may be noted that the average percentage of milk fat in 110 genuine samples was 3.54; the highest contained 5.05 per cent.

All samples of flour submitted were found to be well within the specifications for genuine flour.

Fifty-six per cent. of the samples of Rum submitted were below legal strength. Here again the percentage of adulteration is the highest of recent years.

All coins submitted were counterfeit—the number of counterfeit coins is increasing at an alarming rate. Eight exhibits were received for examination in connection with the manufacture of these coins.

(b) Customs Department.

Condensed milks	11
Petroleums	314
Miscellaneous	6
	331

All condensed milks were of good quality and up to standards required by the English regulations.

Kerosene oils submitted for Flash points were well within limits prescribed by Petroleum Act.

Several samples of Fuel Oil were sent for classification under present Customs Tariff Act. An amended classification has been proposed. It is hoped thereby to simplify the classification of an oil which at present may be assessed under different heads.

Samples of imported Crude oil for the local manufacture of gasolene and kerosene were submitted for evaluation of these constituents.

All gasolenes on the local market were maintained at a uniform good quality, no admixture with any quantity of kerosene was found in any sample.

The miscellaneous items consisted chiefly of liquors submitted for estimation of alcoholic content.

(c) Waterworks Department.

Quarterly analyses of water as supplied through the mains were made. The usual uniform high quality was maintained. Analyses were also made of the fuel oil as supplied to the various pumping stations.

(d) Agricultural Society.

Fertilizers	22
Feeding stuffs	73
Sugars and Molasses	108
	203

The samples of Fertilizers and Feeding stuffs were submitted by the Analytical Committee under the Fertilizers and Feeding Stuffs Act. A good standard of both products was maintained; in many cases however, guarantees of the constituents have not been given as required by the Act. The present Act may with considerable advantage be revised so as to bring it in line with the more recent acts of Great Britain and other countries.

It is to be noted that the number of Fertilizers show a decrease of nearly 75 per cent. as compared with former years —this is mainly due to the diminishing amounts of Organic manures which are now being imported.

The Sugars and Molasses were submitted in connection with the prize awards of the Annual Industrial Exhibition. The number of samples show an increase of fifty per cent. over those of 1930. Apart from actual sugar content, the samples are examined for colour, flavour, and amount of mud present in the molasses. It is of interest to note that all prizes for Fancy Molasses were awarded to Factory syrups as against Open Tayche syrups.

(e) MISCELLANEOUS.

Official 51

These include the following analyses and investigations:

(1) Analysis of fodders and fertilizers made in connection with the manurial trials.

(2) Analysis of molasses, waters, etc., made in connection with advisory work of the Agricultural Chemist.

(3) Examination of the sea water of the Harbour on account of its alleged corrosive action.

(4) Analysis of the drinking water as supplied to steamships. Quarterly analysis of the water supply from well at Mental Hospital.

(5) An investigation on the deterioration of refined granulated sugar when stored under moist conditions in damp warehouses.

(6). Examination and report on samples of water taken from the Water supply of St. Lucia.

Unofficial 284

Under this head are included samples sent by individuals, factories and firms for analysis. They include:

Cane juices	100
Syrups and molasses	53
Hydrometers for calibration	31
Fertilizers and Feeding stuffs	27
Vinegar	13
Petroleum oils	10
Miscellaneous	50
	284

A total of 31 indicator sets for the colorimetric estimation of Hydrogen ion concentration were prepared at the Laboratory and supplied in various Factories and plantations for controlling the clarification of their cane juices.

GARRISON SAVANNAH.

The Garrison Savannah was treated early in June with a dressing of sulphate of ammonia at the rate of one hundredweight to the acre and thanks to this application two very heavy crops were grown which proved entirely beyond the power of the Departmental flock of sheep to keep pace with.

Tenders were invited for the cutting and sale of the grass, but only one application was received. Eventually the second cutting was completed by convict labour (thanks to the co-operation of the Governor of Glendairy prison) and the grass was handed over to the Mental Hospital for use as litter.

As long as the present conditions exist, that is, that the revenue for the maintenance and amelioration of the Garrison Savannah should not be greater than the expenditure no permanent improvement may be expected. Certainly the coarser grasses (such as Bamboo and Christmas grasses) are being gradually exterminated, but the original purpose of converting this open stretch of ground into a number of playing fields will only be achieved when a more concentrated scheme is sanctioned. Such a scheme, however, would involve the employment of a capital expenditure such as is unlikely to be granted by the Legislature at the present juncture.

(b) EXPERIMENTAL WORK OF THE DEPARTMENT.

SUGAR CANE.

During the last four years the solution of the problems of sugar cane breeding in Barbados has become a much more exact science than it formerly was. The original collection of ripe arrows and the planting out of the seedlings raised from them was performed purely on the chance that a good variety might eventually be developed.

As long as the commercial standard was low improvement was comparatively easy but to find even compeers to the B.H.10(12), Ba.11569 and B.726 varieties under the old conditions of experiment became increasingly difficult as each of these varieties was evolved.

Accordingly, to improve the chances or rather to increase the certainty of evolving new and superior varieties recourse was made to the introduction of fresh blood and this, especially where Javan parents were concerned, in the first generation undoubtedly increased the standard of weight.

By using these crosses as parents the Geneticist has during 1931 produced seedlings which, it is estimated, will contain individuals which will retain this increased standard of weight while maintaining the old Barbadian tradition of high sugar content.

The newer method of randomising all seedlings in the first year trial has brought out the different qualities each parental cross can endow its progeny with and it can be safely said that during 1931 definite knowledge has been obtained which will facilitate the production of commercial varieties in the future.

A very promising seedling, B.2935, came through its second year tests exceedingly well and in addition to being put in the season's variety trials it has been planted out on approximately thirty half-acre blocks to test it with the Ba.11569 and the B.891 varieties as a cane for the drier districts of the island.

The cutting back experiment carried out in the 1929-31 crop in the higher tonnage districts with the object of increasing the number of canes to the stool and the weight of the crop was repeated for the 1930-32 crop. These two crop years gave an excellent opportunity to study the effects of cutting back stools in June on cane tonnages, in that the earlier was well below average in rainfall while the later exceeded the average. Both experiments show that cutting back the stools—in the method and time carried out in the experiments— rather than increasing yields has a pronounced depressing effect on the yield of cane. Briefly, while the first anticipation was realised by cutting back, i.e. an increase in the number of shoots, the second, i.e. the development of these increased number of shoots to give an aggregate weight in excess of the non-cut back stools, fell short of anticipations. The canes in the cut back stools were much smaller in length and width than those in the non-cut back stools.

A spacing experiment was carried out on two plantations representative of the typical soils and climates of Barbados and will be dealt with fully at a later date.

The maturity experiments were continued at two stations, representing lower and higher rainfall districts and in these studies all important parents together with any seedlings which have shown exceptional promise are included.

These maturity experiments have demonstrated that while certain imported canes which of themselves may be unsuited to commercial cultivation in the Colony, nevertheless possess certain highly desirable characters (such as drought resistance) for incorporation, through breeding, in the production of new varieties.

COTTON

The spacing experiment in Cotton, carried out during the 1930—31 crop was repeated for the 1931—32 crop. The spacings employed were, (1) that recommended in Pamphlet No. 4 issued by the Department in 1930 (i.e. two rows of cotton plants on each bank between the cane holes; these rows are approximately 2½′ apart with 3′ between each double row. Double plants are allowed to develop every 20″ in each row); and (2) the original spacing carried out in Barbados (i.e. a single row of cotton plants on each bank between the cane holes: thus there is approximately 5½′ between each row). The 1931-32 cotton crop in general gave a lower yield of seed cotton per acre than in 1930—31 due to the unfavourable higher rainfall during the first half of the cotton crop. The spacing experiment showed again an increase in yield of seed cotton per acre by the closer spaced plants over the wider and original spacing. The increase was over 19%, this being 7% higher than the increase due to closer spacing in the 1930-31 experiment.

These two experiments i.e. for the seasons 1930-31 and 1931-32, carried out as they were under entirely different climatic conditions and both showing a highly significant and appreciable increase in yield to be derived from closer spacing, appear to prove conclusively the advantage of this closer spacing in increasing yields and tending to hasten maturity.

The following tables show the cotton production in the Colony for the past three seasons :—

TABLE I.

COMPARATIVE TABLE SHOWING THE ACREAGE PLANTED IN COTTON IN THE VARIOUS PARISHES.

Parish.	1929		1930		1931	
	Plantations.	Peasants.	Plantations.	Peasants.	Plantations.	Peasants.
St. Philip ..	129	22½	543½	390½	381	500
St. Lucy ..	21½	1½	203¼	189¾	120	120¾
St. Peter ..	17	4½	190	29	8½	11¼
St. Thomas ..	5¼	—	42½	—	4	—
St. Andrew ..	—	—	31¾	—	7¾	—
Christ Church	42¾	15¼	385	245	107	93
St. John ..	—	½	29	—	9	—
St. Michael ..	—	1½	103	49½	60	9
St. James ..	10	—	199	55	10	3¼
St. George ..	—	¾	86	2¼	—	10½
St. Joseph ..	—	—	72	½	—	—
	225½	46½	1884	961½	707¼	747¾
Total Acreage	272		2845½		1455	

TABLE II.

TOTAL ACREAGE.

Year	Plantations	Peasants	Total
1929	225½	46½	272
1930	1884	961½	2845½
1931	707¼	747¾	1455

SWEET POTATO.

The sweet potato work for the period under review consisted of two trials (1) a 'Catch' crop trial and (2) a 'Long' crop trial. The former was carried out at Codrington while the latter is being carried out at Ashbury plantation.

Two new importations from Mauritius were included in the 'catch' crop trial, while for the first time the selected 'catch' crop seedlings listed on page 51 of the Annual Report for 1930-31, were given a large scale trial with the best or most promising varieties in hand in Barbados.

It is encouraging to note that seven of the eleven seedlings tried in this trial gave higher yields than the best established varieties.

These seedlings have good growth habits and potatoes of good appearance. It remains to give them further yield and cooking tests.

Of the varieties, V.52 (obtained from St. Vincent) again performed very well, while of the newly tried Mauritius potatoes one did well while the other performed indifferently.

The 'long' crop trial at Ashbury contains the accepted 'long' crop varieties as standards. Also included, are those imported varieties which have shown sufficient merit to deserve further trial and twenty-six seedlings which were selected from the long crop seedling trial at Guinea in May 1931. This trial will be concluded at the end of April.

Economic Legumes.

During the normal rainy season various trials were laid down for the purpose of investigating the position in regard to green manure crops, cowpeas and other edible leguminous crops. No definite conclusions can however be drawn at present owing to the frequent and heavy attack of defoliating and other destructive insects on the various crop plants. The trials, however, reached a sufficiently advanced stage for useful indications to be gained, and the persistent attack of insects led to a search for insecticides which are efficient but at the same time not injurious to soft-leaved leguminous plants. Certain insecticides which were under trial late in the season gave satisfactory results, and their practical application will be further investigated during the coming season.

(a) *Green Manure Crops.*

Stizolobium aterrimum, locally known as Bengal bean, outyielded other varieties, but a creeping variety of the *Dolichos lablab*, the Bonavist, and one or two species of *Vigna,* the cowpea, gave interesting results.

(b) *Cowpeas.*

Various recently introduced varieties were tried against the locally grown Rounceval and Black eye peas. Dixie Queen and Grey Crowder far outyielded the locally grown varieties, and produced their crop in a considerably shorter period.

(c) *Soy Beans.*

A relatively large number of varieties were under investigation, from which it was possible to eliminate a number on general type and to carry over the remainder for further trial.

Garden Vegetables.

Preliminary trials have been conducted with a number of varieties of bush or string beans, carrots and beets. These trials were begun at the end of the rainy season and were conducted by the use of irrigation water.

Very satisfactory and encouraging yields were obtained from certain varieties of bush beans, and the beets, and carrots while not grown definitely for yield observation gave a high percentage of attractive market specimens.

The Indian field pea, a tropical variety of the English pea, has recently been introduced from Mauritius, and is being grown for seed multiplication. The plants have made good growth under irrigation and have podded satisfactorily.

Bananas.

I. Introduction and Object of Observations.

In 1929, when depression in the world's sugar industry was beginning to make itself seriously felt in Barbados, public attention became focussed on the necessity of maintaining agricultural industry in the Island. It was considered that if world's sugar prices became so low as to make sugar production in Barbados unprofitable, at least for a period, it might become necessary to replace sugar cultivation in parts of the island by the cultivation of one or more minor agricultural industries.

Further, the Olivier Sugar Commission in their memoranda sent in advance of the arrival of the Commissioners, strongly advocated the necessity of careful investigation into the cultivation of alternative or subsidiary crops.

At the beginning of the century, a small but useful industry, namely the cultivation of bananas for export to Great Britain, was gradually becoming established when, for reasons beyond the control of the growers, the industry was crippled. This cessation of a more or less flourishing banana industry was enforced by the inability of the steamship lines to make the necessary arrangements for freighting the bananas.

When, however, the Canadian Government in 1929 announced their intention to encourage trade with the British West Indies and placed on the trade route their new "Lady" ships, it was considered that there was a possibility of exporting bananas of a suitable variety from Barbados to Canada.

It was for these reasons that the Department of Agriculture set out to gain some information of the growth habits and yielding capacities of bananas grown under Barbados conditions.

II. collection of varieties.

It was common knowledge that the Cavendish banana, otherwise known as Governor, Dwarf or Chinese banana, was most suited to Barbados conditions, but in order to gain as much information as possible relating to bananas,

an effort was made to collect representative specimens of all banana species and types, including plantains occurring in the Island. Actually, seven varieties of bananas and two varieties of plantains were collected and planted in the general observation plots. The different varieties have been given the local names by which they were known to the suppliers of the suckers. The allocation of their correct names must await examination by a banana specialist.

III. COLLECTION OF DATA.

In respect of each variety, the following information is being accumulated:

(i) height of pseudostem as growth progresses.
(ii) width of base of pseudostem as growth progresses.
(iii) age of plant at time of flowering.
(iv) time taken for bunch to mature.
(v) weight of bunch.
(vi) number of hands.
(vii) number of fingers.
(viii) mean weight of fingers.
(ix) percentage of bad or unsaleable fingers.
(x) the ratio of the weight of the bunch to the time taken for its production for purposes of comparison between plants and stools.

Throughout the dry season and during dry spells in the wet season, the banana stools are kept moist by irrigation. Records are kept of manurial applications made to the stools.

IV. SPECIAL INVESTIGATIONS WITH CAVENDISH BANANA.

(i) *Manuring.*

In order to gain some knowledge of the manurial requirements of this variety a system of plots has been laid out to which

(a) no manure
(b) pen manure and
(c) pen manure plus artificials are applied in definite quantities and at specified times.

(ii) *Irrigation.*

In the same system of plots the effect of
(a) no irrigation
(b) and (c) two approximately known amounts of irrigation water are applied for the purpose of ascertaining the cost and effect on yield of varying quantities of irrigation water.

(iii) *Isolation of early maturing and high yielding strains.*

The great range in the length of time taken by various plants and stools to produce bunches has suggested the possibility of the existence of definite

early maturing and at the same time average yielding strains of the Cavendish banana. Records are being kept in order to investigate this matter: but it is considered that no definite information will be available before several years have elapsed.

(iv) *Number of suckers per stool.*

Investigation is being conducted into the number of suckers per stool which will yield best economically.

(v) *General.*

In addition to the investigations already enumerated, the data listed in section (iii) is also being accumulated in respect of the Cavendish variety.

V. INTRODUCTION OF NEW VARIETIES.

On the recommendation of the banana expert at the Imperial College of Tropical Agriculture, two varieties, (viz. Lacatan and Congo) hitherto unknown in the Island and considered likely to do well under Barbados conditions, have been introduced.

SECTION V.—CHEMICAL SECTION.

SUGAR TECHNOLOGY.

1. *Advisory.* A large number of advisory visits have been made to Dark Crystal and Syrup factories by the Agricultural Chemist during the crop season of 1932. A scheme has been submitted to, and approved by, the Board of Agriculture by which it is proposed to introduce chemical control into the smaller factories. The proprietors of seven or eight of these factories have already intimated their readiness to participate in this scheme.

2. *Investigational.* In the limited time available, a continuation of the investigation into the crystallisation of low purity massecuites has been continued at Bulkeley Factory where a crystalliser has been equipped with cooling coils.

The work carried out on the Quick Vinegar procees for converting cane juice into vinegar can now be regarded as completed. Two large generators have been erected by the management of Carrington Factory. These generators are capable of producing 100 gallons of vinegar per day and are working satisfactorily.

An investigation has been made of the optimum conditions for the inversion of the desired amount of sucrose in cane juices in the manufacture of Fancy Molasses. From a study of these conditions methods for inversion in the factory have been suggested.

MANURING OF SUGAR CANE.

The manurial experiments carried out on sugar cane during the past five years have yielded results of considerable practical importance and show that the cost of manuring on many plantations can be considerably reduced. The system of manuring recommended by the Agricultural Chemist will save, in most cases, at least $10.00 per acre without affecting the yield of cane. A number of planters are now adopting the system recommended.

SOILS.

The sampling and analysis of soils has been continued in the out-of-crop season and advisory reports are issued by the Agricultural Chemist with recommendations as to manuring.

An investigation into the nitrogen status of an arable soil, without vegetation, was carried out during 1931. Samples and analyses of total, nitrate and ammoniacal nitrogen were carried out weekly. This work is being continued during 1932. Results of considerable interest are indicated.

SECTION VI.—ENTOMOLOGICAL SECTION.

The mass production and early and uniform liberation of the parasite *Trichogramma* to control *Diatraea* in cane has continued on normal lines. The third cane crop grown under this protective measure has now been reaped and analysed in field, factory and laboratory, and the results show a continued reduction in infestation.

This reduction has been sufficiently satisfactory to the planters in Barbados to induce them to subscribe enough money to erect and equip four more moth breeding units. These were built towards the end of 1931, thus enabling a doubling of the output of parasites for the 1932 growing season.

The work of doubling the output has entailed no inconvenience or alteration of the main routine but has proceeded on normal lines.

In addition to the control of moth borer evidence has been obtained of progress in the control of root borer (*Diaprepes*) by means of co-operative hand collection of beetles and eggs.

The egg parasite *Tetrastichus* introduced from Haiti for the control of this pest failed to breed here, whilst the *Tetrastichus* from Porto Rico though successfully propagated in the Laboratory and liberated in the field to the extent of 20,000 has not since been recovered from the field.

The parasite *Lixophaga* which was introduced in 1930 to control *Diatraea* has also not yet been recovered.

The parasite *Compsilura concinnata* was introduced from America, for the control of army worms, etc., but very few survived shipment; this introduc-

tion is being repeated in 1932. It is also hoped to again introduce *Tetrastichus* from Porto Rico but at an earlier and more favourable time.

SECTION VII. METEOROLOGICAL OBSERVATIONS.

In recent years a system has been evolved whereby weather reports are issued during the hurricane season by the meteorological station of this Department on the request of other Stations in the West Indies or of ships at Sea, or on such other occasions as the Officer in charge of the meteorological section of the Department considers advisable.

During the hurricane season 1931, eleven reports were issued on request and five reports voluntarily.

APPENDIX I.

METEOROLOGICAL OBSERVATIONS.

RECORDED AT THE METEOROLOGICAL STATION, CODRINGTON.

Height Above Sea Level 181 Feet.

Latitude 13°7′ 36″ N. Longitude 59°35′ 57″ W.

The following are summaries of the observations recorded for the year 1931. The details are given in Appendix II.

Barometric Pressure.—The records refer to observations made at the hours of 9 a.m. and 3 p.m. only and are expressed in inches of mercury. During the year 1931 the mean pressure corrected for temperature and gravity and reduced to sea-level was at 9 a.m. 29.965 and at 3 p.m. 29.884, the highest pressure recorded being 30.086 at 9 a.m. on March 22nd and the lowest 29.768 at 3 p.m. on September 14th. For the ten-year period 1921-30 the average barometric pressure was at 9 a.m. 29.978 and at 3 p.m. 29.902. The highest pressure recorded at 9 a.m. during the ten-year period was 30.127 inches on January 22nd, 1925, and the lowest pressure recorded at 3 p.m. was 29.694 inches on September 8th, 1921.

Temperature.—The daily mean maximum temperature for the year 1931 was 85.9°F. and the daily mean minimum 72.9°F. The maximum extreme for the year was 90.0°F. registered on May 15th, 17th, 18th and 20th and the minimum was 64.0°F. registered on January 10th. The average daily mean temperature was 79.4°F., the highest monthly range 22.5°F., and the lowest 15.0°F., the mean monthly range being 17.9°F. For the ten year period 1921-30 the daily mean maximum temperature was 85.2°F., and the daily mean minimum 72.6°F. During the ten-year period the average daily mean temperature was 78.9°F., the maximum extreme was 91.5°F. on August 23rd, 1927, the minimum extreme 63.2°F on March 24th 1925, and the average monthly range 18.4°F.

Tension of Vapour and Relative Humidity.—The mean tension of vapour for the year 1931 was at 8 a.m. .782 and at 5 p.m. .775. The mean relative humidity was at 8 a.m. 75.1% and at 5 p.m. 73.6%.

Wind.—The daily (24 hour period) mean velocity of the wind during the year 1931 was 9.6 miles an hour. Records were kept of half daily or 12 hour periods from 6 a.m. to 6 p.m. and 6 p.m. to 6 a.m. The maximum velocity for any such 12 hour period was 21.8 miles an hour, recorded between 6 a.m. and 6 p.m. on April 8th and the minimum velocity was 2.8 miles an hour, recorded between 6 p.m. and 6 a.m. on November 14th. The average daily (24 hour period) velocity for the ten years ended 1930 was 10.3 miles an hour.

Rainfall.—The rainfall measured at the Government Meteorological Station during the year 1931 amounted to 62.54 inches. Raintall was recorded on 219 days, the greatest fall being 2.77 inches on November 1st. For the ten-year period 1921-30 the average rainfall was 44.15 inches and the average number of days annually on which rain fell was 182.

Rainfall of the Island.—The average total rainfall for the year 1931 from 175 stations was 73.39 inches, being 13.52 inches above the average for the eighty-four years ended December 31, 1930, which was 59.87 inches.

APPENDIX II.

METEOROLOGICAL REPORT FOR 1931.

DEPARTMENT OF AGRICULTURE, BARBADOS.

Height Above Sea-Level 181 Feet.

Months.	Barometric Pressure reduced to 32° F., Latitude 13° 7′ N., Mean Sea-level, and corrected for gravity.					Temperature °F.								Tension of Vapour			Relative Humidity.			Wind.	Rainfall.	No. of days on which rain fell.
	9 a.m.	3 p.m.	Mean.	Highest.	Lowest.	Maximum Mean.	Minimum Mean	Maximum Extreme.	Minimum Extreme.	Mean for Month.	Range for Month.	Dew Point 8 a.m.	Dew Point 5 p.m.	8 a.m.	5 p.m.	Mean.	8 a.m.	5 p.m.	Mean.	Velocity, miles per hour.		
January ...	29.989	29.901	29.945	30.036	29.851	84.5	69.8	86.5	64 0	77 2	22.5	68.6	68.0	.706	.686	.696	75.0	70.2	72.6	8.7	1.15	13
February ...	29.955	29.878	29.917	30.045	29.828	85.3	70.0	87.5	66.5	77.7	21.0	70 7	71.9	754	.789	772	78.0	78.6	78.3	9.3	.64	10
March ...	30.001	29.913	29.957	30.086	29.869	87 1	71.1	89 0	68.0	79.1	21.0	69·3	69.9	.718	736	.727	68.4	69.3	68.9	8.1	.97	6
April ...	29.969	29.886	29.928	30.055	29 831	87.1	73.0	89.0	70.5	80.0	18.5	70.2	70.7	.741	.756	.748	68 9	69.4	69.2	9.4	1.37	10
May ...	29.954	29.819	29.887	30.008	29.835	88.4	74.8	90.0	72.0	81.6	18.0	71.3	66 0	.769	.761	.765	69.0	66.2	67.6	10.4	1 62	13
June ...	29,993	29·933	29.963	30 065	29.875	86.4	71 4	88.5	72.0	80.4	16 5	73.6	72.7	831	.800	.815	76.8	74.0	75.4	11.1	12.46	26
July ...	29.951	29.893	29.922	30.033	29.821	85.6	74.5	87.0	71.0	79.9	16.0	73.8	72.5	.833	.824	.828	78.8	77.0	77.9	10 3	9.48	28
August ...	30.001	29 936	29.969	30.065	29.879	86.2	74.6	87.0	70.4	80.4	16.6	73.3	72.7	.825	.807	.816	76.6	73.2	74.9	10 0	6 35	23
September ..	29 914	29 870	29.907	30 080	29 768	86 6	73.8	87.5	72.0	80.2	15.5	72 8	72.0	810	.787	.799	75.8	71.9	73.8	8.1	9.79	24
October ..	29 946	29.871	29.909	29.998	29.785	85.7	71.5	86.5	71.5	80.1	15.0	73 8	73.2	.837	.819	.828	78.2	78.4	78.3	10.1	7.44	23
November ...	29.891	29.812	29.852	29.973	29.718	81.4	73.3	86.5	70.5	78.8	16 0	73.7	73.0	830	.813	.822	82.1	82 1	82.1	8.7	10.43	26
December ...	29.981	29.899	29.940	30.047	29.843	83.8	71.8	85 0	67.0	77.8	18.0	69.7	69.3	.730	.722	.726	74 2	72.9	73.6	11.8	.84	17
Average ...	29.965	29 881	29.924	30.040	29,825	85.9	72.9	87·5	69.6	79.4	17.9	71.7	71.0	.782	.775	.778	75.1	73.6	74.4	9.6	62.54	219

SECTION VIII.—PEASANTS' AGRICULTURAL EXHIBITION.

The usual Exhibition for Peasants and Elementary School children was held, by kind permission of the Queen's Park Committee, in the Queen's Park on Thursday, 3rd December, 1931.

The Exhibition was extremely successful and the attendance very encouraging.

After the splendid growing season the standard and numbers of the exhibits were exceedingly good.

The animal exhibits were, however, poor and although the experiment of holding the Exhibition in Bridgetown is worthy of an extended trial, some additional encouragement will be necessary to induce stock-owning peasant farmers to bring their cattle and donkeys, etc. forward for competition.

SECTION IX.—VISITORS.

Among the visitors to the Department during the year under report were His Excellency the Governor, Sir William C. F. Robertson, K.C.M.G., Sir Thomas Vans Best, K.B.E., Governor of the Windward Islands; Dr. S. C Harland, Geneticist, Cotton Research Station, Trinidad; Mr. G. Evans, M.A., C.I.E., Principal of the Imperial College of Tropical Agriculture, Trinidad; Professor H. A. Ballou, M.Sc., Commissioner of Agriculture for the West Indies; Professor R. Cecil Wood, M.A., Imperial College of Tropical Agriculture, Trinidad; Dr. H. R. Briton-Jones, Mycologist and Bacteriologist Imperial College of Tropical Agriculture; Mr. G. D. Owen, Colonial Secretary; Mr. Alfred Single, Chief Chemist, Department of National Revenue, Canada; Mr. G. G. Auchinleck, Director of Agriculture, Gold Coast, Messrs. C. E. Cooley and M. Kislink, Federal Entomologists, United States of America.

SECTION X.—ACKNOWLEDGMENTS.

The Director of Agriculture desires to record his appreciation of the assistance rendered by:—

(1) The Board of Agriculture throughout the year.

(2) The Management of Lion Castle Plantation, by granting the Department the use of land for conducting sugar cane breeding and by facilitating the work in every way possible.

(3) The Management of Carrington Factory by permitting the Agricultural Chemist to conduct research work in Sugar Technology in Carrington Factory during the grinding season of 1932.

(4) The Managements of Waterford, Yorkshire, Ridgeway, Lemon Arbor, Fisherpond, Haymans and Warleigh, by selling canes to the Department for

the purpose of distributing healthy cane cuttings to areas infected with Mosaic Disease;

(5) The Management of Ashbury Plantation for granting the use of land for sweet potato experiments;

(6) The Managements of Vaucluse and Graeme Hall Plantations by granting special facilities for maintaining maturity experiments until the end of the reaping season;

(7) The United States Department of Agriculture by supplying this Department with cuttings of sugar cane varieties passed through quarantine and by supplying seeds of various economic plants;

(8) The local Press and especially the "Advocate" for assisting the Department at all times when publicity has been necessary.

September.		October.		November.		December.		Total.	
Days.	Inches.	Days.	Inches	Days.	Inches.	Days.	Inches.	Days.	Inches.
18	9.61	18	9.28	21	10.32	9	.75	171	64.23
18	9.85	17	7·31	18	11.72	7	.85	165	67.40
20	15.92	18	11.19	21	12.54	9	1.15	189	84.83
19	12.06	17	9.42	16	11.86	7	1.07	171	73.60
19	12.06	18	7.29	20	14.18	9	.92	188	69.25
19	8.47	18	6.72	18	12.35	7	.73	172	60.78
20	11.34	19	9.39	22	16.11	7	1.18	186	81.43
18	10.67	17	7.52	18	13.15	5	.55	150	65.05
21	15.46	23	9.57	20	10.35	10	1.60	196	80.72
19	13.81	19	10.21	17	9.60	9	1.29	169	73 18
13	14.13	17	8.46	14	11.33	5	1.03	156	79.70
17	11.36	18	7.10	15	8.26	7	1.02	161	63.85
14	12.91	18	9.92	18	13.31	6	1.06	154	76.82
17	13.20	20	9.04	17	9.96	7	1.16	170	69.16
16	11.85	18	8.33	17	11.14	5	.59	148	66.02
21	14.89	21	9.77	21	14.21	8	1.24	199	84.49
14	15 37	18	11.63	16	17.72	7	1.01	155	91.23
15	13 42	19	9.04	18	11.57	7	1.03	160	75 26
12	9.18	13	9·01	13	11.26	3	.56	135	67.36
339	235.56	316	170.23	340	230.94	134	18.79	3,195	1,394.36
17	12.40	18	8.96	18	12.15	7	.99	168	73.39

Some Aspects of the Flora of Barbados.

BY

F. HARDY, M.A., Dip. Agric.

2ND INSTALMENT.

(Continued from last issue).

CHAPTER V.

SOIL FACTORS.

So far we have seen that the general nature and distribution of the vegetation in different parts of Barbados, whether that vegetation be natural or cultivated, has been decided to a marked extent by the climate and the topographical features of the Island. When we come to consider the minor details of plant distribution, we find that the nature of the substratum in which the different assortments of plants are living, plays an important part in deciding the limits of the area inhabited by them. By "substratum" it is meant to imply, not only what is ordinarily known as soil, but soil and the material which underlies it, namely, sub-soil and solid rock. Of these three layers of a substratum, the lowest, namely solid rock, may be porous or non-porous. Amongst kinds of rock that are porous may be mentioned coral limestone, chalk and sandstone, and amongst non-porus rocks, slate, clay and granite may be taken as examples. The conditions of growth of any plant are intimately bound up with the nature of the substratum in which that plant is growing. There are five considerations which decide whether or no a plant will grow successfully in its habitat. They are (1) Water supply, (2) Air supply, (3) Root room, (4) Soil Temperature, and (5) Nutrients in the Soil. If these five factors are suitable to the requirements of a plant which starts life in a particular habitat, then that plant will continue growth and will thrive successfully.

1. *Water Supply.*

This term is meant to include, not only the total amount of water contained in the soil in the immediate neighbourhood of the root-system of a plant, but also the ease with which this soil can be kept moist by the passage of water from the surrounding substratum. Water supply depends primarily, of course, on rainfall. It also depends on the ability of the substratum to absorb the rain that falls on its surface, and on the power of the substratum to retain that water and to store it in such a way that it may gradually become available to the plants growing in it.

A substratum whose upper layer consists of good loose soil can absorb water almost as quickly as it falls on it as rain, and, provided that the sub-soil and rock below are also porous, much of this water can be passed on to the underlying layers which will thereby act as a storage reservoir. On the other hand, a substratum whose upper layer consists of only a very thin layer of soil will have little chance of absorbing water since rain will quickly run off its surface.

The conservation of absorbed water by a substratum whose upper layer consists of deep soil is also much better than that by a substratum which possesses only a thin layer of soil, for a thick layer of soil acts as a protective covering, minimising loss of water by evaporation. This protective action is rendered even more effective when a layer of dead vegetation (for example cane "trash") lies upon the surface of the soil.

For a soil to make the best use of the water with which it is supplied, that is, for it to retain the maximum amount of that water and to store it up in such a way that plants growing in the upper layers of the soil will be able to draw on it as they require it, that soil must possess certain physical properties which are shown by practical and theoretical considerations to depend chiefly on its *texture*. By "texture" is meant the structure of the soil as determined chiefly by the relative size of the particles of which it is composed, and by the mode of packing or arrangement of these particles. Amongst the physical properties of soil, the following are the more important and have direct bearing on water supply:—

(a) *Capacity*—decided by what percentage of the total volume of the soil is pore space.

(b) *Porosity*—decided by the average size or area of section of the pore spaces.

(c) *Facility of percolation and freedom of movement of water* from one place to another in a soil.

(d) *Capillarity*—or ability to draw up water from the lower to the upper layer where water is being removed by evaporaton from the soil and from plants growng in it.

(e) *Retentivity*—or power to hold water as surface films round the particles. This is decided chiefly by the size of the particles of which the soil is composed.

A sandy soil, for instance, consists of relatively large particles loosely arranged. The pore space is comparatvely great and, therefore, sandy soil can store, when waterlogged, considerable quantities of water. The soil is also very porous, and rain can soak into it very readily, and can also percolate rapidly both vertically and laterally. The capillarity of sandy soil, however, is very low, for water will not rise very far in it, although it rises rapidly over any distance through which it is able to rise. Finally, sandy soil is not very retentive of water, since the extent of the films which occur round each particle of the soil when properly drained is not very great, the particles being large, and having a relatively small area of surface.

A clay soil, on the other hand consists of relatively small particles, closely

packed. It possesses small water capacity, is not very porous, takes a long time to become wetted, and transmits water slowly. It is also very retentive of moisture and therefore dries slowly.

These facts make it clear that a soil which is neither too sandy nor too clayey is the best soil for the majority of plants, and it is the aim of agriculturists so to alter or modify the physical properties of soils by tillage, drainage and manuring, that they will present the best conditions possible for the successful growth of the plants they cultivate.

In Barbados, the soil of sugar estates is ploughed, forked and hoed so as to break it up and to improve (amongst other things) its physical properties. In the waste lands, the tilth of the soil is poor, and such lands, therefore, suffer more quickly from drought than do the prepared cane lands. On the sea shore, (especially, where the soil consists of almost pure sand piled up in heaps as it is in the sand-dune districts), the physical properties of the substratum are such that the water supply is extremely scanty, and only certain very specialized plants can grow at all in these regions. When the plant associations of sandy beaches and of sand dunes of Barbados are considered in detail, a fuller account of the exacting conditions of plant growth occurring in such habitats will be given.

The ultimate *mode of occurrence* of water in a substratum is of great importance in connection with vegetative activity. Considering a simple case, such as a deep layer of soil of good tilth overlying an impervious bed of some such material as clay, it is to be noticed that any water which gains access to that soil, (whether it falls directly on it as rain or whether it accumulates in it by underground movement or "seepage"), percolates down to the impervious base and then starts to saturate the lower layers of the soil. The level to which the zone of saturation eventually rises is called the "water table." It fluctuates very much according to the seasons of the year and according to the rate at which the ground water is removed by plants or by leakage. Water sometimes ascends by capillarity from the level of the water table to the upper layers of the soil in which the majority of the plant roots are embedded. Capillarity (as has already been stated) is a property possessed by soils to different degrees. It depends on the texture of the soil; fine-grained soils showing greater capillarity than coarse-grained soils. Whereas the soil below the water table is waterlogged and contains no air, the soil above it, although plentifully supplied with moisture, contains air in its pore spaces, the water existing only as films round the soil particles.

The depth of the water table has great significance in connection with plant growth. It affects two things,—air supply and root room. Let us consider the question in connection with deep layers of soil in which the water table stands at different levels below the ground surface.

2. *Air Supply of a Soil.*

Certain plants cannot live in soil in which the water table is very high, for such a soil practically constitutes a marsh. Air is absent from it, and plant roots must have air in order for them to remain healthy and to produce their root hairs. When the water table is at a higher level than the ground level, water accumulates as ponds. In ponds, only certain very specialised plants can grow,

because the air supply is in the form of dissolved gas. Finally, certain plants cannot live in soil whose water table is a long way below the surface, even though the air supply is good. Their roots cannot penetrate down to the moist regions, and they may suffer considerably from drought.

3. *Root Room.*

The extent of the root systems of different plants vary in great degree. Plants of the Monocotyledons (consisting chiefly of grasses) have fibrous roots which ramify in the upper layers of soil chiefly, whereas Dicotyledonous plants (including almost all the common trees and shrubs of Barbados) possess root systems which consist of a central deep-growing axis or "tap-root" which bears numerous side branches. The root systems of many grassy plants require therefore only shallow soil, whereas those of the majority of trees and shrubs can grow successfully only in deep soil. Water attracts roots towards it, and hence the presence of a well-marked water table low down in a good deep soil results in the production of long and profusely-branched tap root systems, by those plants which are able to produce them.

In a soil where the water table is high, or where the impenetrable subsoil or solid rock is at only a small distance below the ground level, plants which normally produce long tap root systems will be unable to produce them here. Unless those plants can adapt themselves to the new conditions, they will not be able to succeed in a soil of small root room and they will be ousted by plants more fitted for life under the prevailing circumstances. Thus the root room of a substratum has important bearing on the nature of the vegetation that is able to grow successfully in that substratum.

Many of the above results in connection with the effect of the depth of the water table on the growth and distribution of plants are demonstrated to a more or less striking degree in Barbados. The complications which the presence of the fairly porous but slowly absorptive coral rock beneath the soil in most parts of the Island involve, are difficult to estimate, especially since few definite data (such as those obtained by boring or digging) are available. If one assumes that the coral rock is permanently saturated with water, that is, never loses sufficient water even in severe and prolonged periods of drought seriously to reduce its store of water, then the water table problem of the soils of most districts becomes simplified. A definite water table most certainly exists in many sugar estates during all but the very driest of weather. In several regions near the coast, (especially on sandy beaches) its depth below the ground can easily be found by digging a hole and waiting until water collects in it to a stationary level. Very striking relationships between the plant population and the depth of the water table can be established by an investigation of the problem in certain localities near the coast in Barbados. One such investigation is to be described in another place, and there is reason to believe that the study of carefully selected areas in the Island (such as, for instance, Belle Plaine) along these lines would produce very interesting and instructive results. At least they would indicate the importance of the question of the mode of occurrence of water in certain types of substrata, and would explain many observed facts in connection with plant life as it occurs either under natural or under artificial (agricultural) conditions.

4. *Temperature of the Soil.*

The importance of the range of atmospheric temperature has already been discussed. It remains to note now the effect of *soil* temperature on plants and to decide to what causes soil temperatures, (differing sometimes markedly from the average air temperatures near the soil) are due.

The activity of the processes which go on in roots is decided actually by soil temperatures and not by air temperatures. Water absorption is influenced directly by temperature, for the higher the temperature the more rapidly does absorption proceed. Further, for root growth to go on, the soil surrounding the roots must always be above a certain temperature, the average value of which is about 4° Centigrade.

In the tropics, the question of soil temperature is not so important as in other regions, since the air temperature there never falls so low as seriously to affect that of the soil. In many polar regions, were it not for the fact that the soil is at a temperature of a few degrees above that of the surrounding air, no vegetation would grow at all. In temperate countries soil temperature in properly cultivated ground makes it possible for seeds to germinate in comparatively cold weather, and thus to influence considerably the period of vegetative activity, so that "warm" soils produce early crops.

The chief factor that influences soil temperature is undoubtedly the amount of water in the soil, because heat is used up in the warming and evaporation of the soil-water. Wet soils are "cold," that is, their temperature is below that of the surrounding air. Naturally, therefore, those factors that tend to increase evaporation, (such as wind) cause a lowering of the soil temperature, and *vice versa*. Further, much more heat is required to warm up wet soil through a certain temperature-range than is required to warm the same quantity of dry soil or solid rock through the same range.

Another factor that influences soil-temperature causing it to be greater or less than the temperature of the surrounding air, is the colour of the soil, for dark coloured soils absorb the sun's heat more rapidly than do soils of a lighter colour, and at night dark soils lose their heat more rapidly than do light coloured soils.

In Barbados the temperature of cultivated soils is not much different from that of the air. There are few "wet" soils in the Island, and "cold" soils are rare. But rocky districts occur in many places, and here the temperature of the substratum may rise so high during the day time that plant life may thereby be considerably affected. Sandy soils, too, suffer in the same way, and the soil temperature factor is one which must not be ignored in investigating the flora of such regions as dry sandy beaches and coastal dunes.

5. *Nutrients in Soil.*

A typical surface soil consists of three distinct parts, (a) solid inorganic or mineral particles; (b) solid organic particles and (c) soil water,—which contains nutrient salts in solution.

The inorganic part of a soil has been derived from rocks, and the organic

part from decayed vegetation. It is not intended to give here a full account of the way in which rock becomes transformed into typical soil, nor of the nature of the chemical changes that go in this process which results in the gradual production of soluble salts. Full details may be obtained from books on Agricultural Chemistry, such as those named in the Bibliography at the end of this book. Suffice it to state that all green plants require certain chemical elements (combined together in such substances as Potassium salts, Calcium salts, Magnesium salts, including Nitrates, Phosphates, and Sulphates, and also in addition traces of Iron compounds) for their successful growth. Most natural soils contain all these essential constituents, but in certain cases the soils are either deficient in one or more of them, or else the compounds are not produced sufficiently rapidly to meet the demands of vigorous and closely growing plants. Hence planters apply manures and till the ground extensively in order to make up for these short-comings in soils in which they intend to grow crops.

As regards the soils of Barbados, it may be remarked that over the larger part of the surface of the Island the soil has been tilled and manured for several generations. After all the natural virgin soil (which was laid bare as the primeval forest was cut down) had been brought under cultivation, the planters had to rejuvenate the land in order to make it continue to produce crops successfully. Hence considerable changes have been brought about in the composition of Barbados soils as a result of the influence of man. This fact must be borne in mind when chemical analyses of typical samples of the soil are scrutinised.

The natural history and the chemical composition of the soils of Barbados have been described by Harrison and Jukes-Brown in their "Geology of Barbados" (1890) Chapter VII. These investigators divide the soils of the Island into "Soils of the Coral Area" and "Soils of the Scotland District." They dwell at some length on the interesting and puzzling problem of the origin and differences between the red and the black soils of the coralline regions of the Island. By a consideration of the chemical composition of these soils, and of the topography and history of the districts in which they are found, they reach the conclusion that the Barbados black soil of the lowland regions has in part been derived from the red soils of the uplands and has been transported into its present site by the action of running water and by natural gravitation from higher to lower levels. The Scotland District soils include a variety of types, the nature of which indicates the marked relationship between the composition of the underlying rock and the chemical properties of the soils derived from them. The case of the alluvial soils of the valleys and flats in the Scotland District, (consisting as they do of rain-washed materials from the hilly land), exhibit special features by reason of their origin and mode of deposition.

Sufficient evidence as to the composition of the soils of the uncultivated districts of Barbados has not yet been accumulated to throw light on the relation between the quality of the nutrients in these soils and the form of vegetation that occurs on them. One would expect that the soils of most dry pastures and of rocky waste places would prove on examination to be poor in one or other of the essential plant nutrients, judging by the scanty and scrubby vegetation that is found on them, and arguing by the analogy that similar vegetation in other regions of the earth's surface always characterises soil poor in nutrient substances. The case of the substratum on the sea beaches is at first sight fairly easy to imagine. One would not expect to find all the necessary constituents of mineral plant food present in sufficient quantity in such a soil as sea shore sand. Yet many plants

grow quite luxuriously in this medium. In fact, experiment and observation show that the nutritive substances indispensable to higher plants occur in nearly all soils, and that only a very small amount of these substances is required by the majority of plants for successful growth.

Note should also be made of the fact that plants can exercise a power of quantitative selection, absorbing the various substances presented in solution to their roots in proportions other than those in which they occur in the substratum. Plants also to a certain limited extent exercise a power of qualitative selection, in that they absorb only certain substances and reject others. For instance, they are unable to absorb water containing a high proportion of common salt. Plants growing in very salty soil then, can obtain only a minimum of water even though the soil appears to be almost saturated with it. Hence those plants which are able to grow successfully in salty soil possess such structural features as enable them to economise water, and to lose little of it by transpiration (or evaporation from their leaves and stems). They constitute a special class of plants known as "Salt plants" (or Halophytes) of which more will be said later. In many regions near sea coasts the soil is charged with common salt which gains access to the land during periods of tidal flood, or which penetrates into it by seepage from the sea. Such "salt marshes" support a characteristic vegetation of halophytes. In Barbados only a few samples of salt marsh vegetation are to be found at the present day, and although they are not very typical, yet they give some idea of what a true halophytic plant association is like. It is highly probable that salt marshes were very common in certain parts of Barbados in past ages, for indications of their former existence in many places (as for instance, along the southern coast) are still to be seen.

Finally, other chemical compounds such as calcium carbonate (lime), when present in excess in soils are said to act as does common salt. Only plants with certain structural modifications can perhaps tolerate large quantities of lime, and soils which contain, say 3% and upwards of calcium oxide occasionally exhibit the fact by being able only to support plants of a certain kind. In Barbados very few or no cultivated soils contain as much as 3% of calcium oxide (see "Geology of Barbados" Harrison and Jukes-Browne, pp 51 & 55), and the same may perhaps be said of soils of waste places, with the exception of the scanty soil in course of formation on heaps of limestone debris, or on the newly exposed coral rock of quarries and marl pits. One might expect that, since the rocks in the Scotland District are of different chemical composition from the coral rock of the rest of Barbados, the plants of that district would show marked differences from those of the coralline regions. This appears on investigation not to be so, the reason being that no definite inference can be drawn from the fact that because a rock mass is composed chiefly of calcium carbonate the soil derived from it will possess an abnormal percentage of lime. Chemical analysis shows the fallacy of this tempting conclusion, and illustrates the need for caution in coming to hasty decisions in such intricate considerations as the relation between rocks and soils.

CHAPTER VI.

BIOLOGICAL FACTORS.

Of biological factors, the influence of man is by far the most important and profound. In order thoroughly to understand how far man has affected the vegetation of Barbados, it would be well to consider first the past history of the Island.

Barbados was first colonised by civilised man in 1625, when a party of some forty Englishmen landed on the Leeward coast. According to Ligon who visited the Island in 1647, Barbados was at first overgrown with forests and thickets, and the early settlers had great difficulty in planting crops, so massive and close growing were the trees. The Civil Wars in England caused many more colonists to seek homes in Barbados. In 1676, over 2,000 whites and 32,000 negroes were living there. Deforestation went on at a rapid rate from this time, the process being greatly accelerated, by the increase in the cultivation of sugar cane which had been commenced in Barbados in 1640 or thereabouts. Many of the trees were cut up and shipped away. Fustic, Logwood, Lignum Vitae and West Indian Cedar were the chief timbers exported. Large quantities of wood were used as fuel in sugar manufacture, and houses and estate buildings were erected out of felled trees of such species as Locust, Mastic, Bullet Tree, Red Wood (or Sea Grape) and Yellow Wood (Zanthoxylum). During these early days, many plants were introduced into the Island either to be grown as fodder or to be cultivated as crops. Records indicate that Maize, Sweet potato, Yam, Cassava, Plantain, Banana, Ginger, Bonavist, Tobacco, Aloes and Sugar-Cane were introduced for one or other of these purposes soon after the date of settlement, while Cotton and Indigo, which were found growing wild in the Island, were also cultivated for export. Later, many other plants were brought to Barbados from different parts of the world. Many of these are nowadays very common in the Island, so much so that most people imagine that they are native plants of Barbados and belonged to its aboriginal flora. Mahogany, Tamarind, Evergreen, Woman's Tongue, Barbados Almond, Flamboyante, Frangipani, Mango, Orange, Lime and most ornamental garden shrubs and herbs are introduced plants, as are also several weeds and uncultivated shrubs and herbs which have become so well established that they even enter into the natural plant associations in the different regions of the Island.

In very few places only are the relics of the ancient forests of Barbados nowadays to be seen. The best impression of their botanical characters is furnished by Turner's Hall Wood in the Scotland District. This area will be described in a subsequent chapter. The only other remaining region of primitive forest land in the Island is Forter Hall Wood situated under the brow of Hackleton's Cliff. In certain gullies, the vegetation is probably similar to what it was in the early days, but gullies have received attention from man, and in many cases have suffered somewhat from his interference. Nevertheless, a study of the vegetation of gullies will help to convey some general idea of the nature of the primeval flora of Barbados.

Man has completely altered the face of the country in all parts of the Island, and he still continues to alter it in small degree by his conscious or

unconscious interference with its vegetation. He cultivates the soil and grows crops for pecuniary gain and for his own use. On the cultivated land certain weeds to a limited extent are, however, able to flourish. Waysides, ditches and a few ponds owe their existence to man's activity, and although the majority of plants growing in these habitats are self sown, yet many of them probably belong to the primeval vegetation and have taken refuge there. Hence in seeking to understand the reasons for the distribution of plants in Barbados, man's influence has to be considered as a very important factor. In a few regions in Barbados is man's influence not felt. Such places, however, as sea beaches, rocky places, certain of the deeper gullies, and cliff faces, owing to the poorness of soil, exposure to wind, lack of moisture or inaccessibility, are quite unsuitable for cultivation, and have therefore received little direct interference from him.

Even in these places, as well as in many pastures and along waysides, animals such as goats and sheep, for whose introduction into the Island man is primarily responsible, considerably influence the vegetation by their grazing. They prevent trees from growing up and converting certain districts into forest land again, and incidentally, they unconsciously bring about the dissemination of many plants whose fruits or seeds adhere to their bodies.

THE RELATIVE IMPORTANCE OF THE VARIOUS FACTORS WHICH HAVE INFLUENCED THE DISTRIBUTION OF PLANTS IN BARBADOS.

In discussing the reasons why the present day plant population of Barbados (including as it does both cultivated and wild plants) comes to consist of particular kinds and assortments of plants which constitute it, one must constantly bear in mind that the nature of the Barbados flora prior to the advent of man on the Island was very different from what it is to-day.

The composition of the aboriginal flora, and the distribution and grouping of the species of plants which comprised it, was undoubtedly determined by the important factors—climatic, topographical and soil factors—just as the flora of any other land area is determined by these factors when once it becomes colonised by plants. It is not intended to discuss in this place what were the natural means whereby Barbados originally became colonised by plants, as the question is to be considered in the last part of this book.

It is almost certain that the aboriginal flora of Barbados was fairly uniform in type throughout the whole extent of the Island, and that rainfall was the chief factor instrumental in fixing its general composition as the flora of an area within the tropical American Zone. Probably the flora of Barbados always did differ in marked degree from that of the more rainy islands of the West Indies, and from that of the South American continent. The surface configuration of Barbados has probably never been sufficiently varied for topographical factors other than those having a direct bearing on rainfall to have had much effect on the aboriginal flora; nor were variations in the soil conditions of the Island in the early days probably sufficiently well marked to have influenced to any appreciable extent the distribution of the plants which composed the primeval vegetation.

When man commenced his activities in Barbados, no doubt he quickly upset the balance which had probably been set up within the plant associations that made up its primitive flora. Firstly, his removing the larger trees would cause

a lowering of the rainfall, and would also open up the land to the direct action of wind and sun, so that the undergrowth once protected, would now suffer considerably through the absence of shelter. Tillage of certain parts of the land next would expel many low-growing plants which would thereafter be able to live only in those places where tillage operations were not performed. Following the spread of plant cultivation by man, the soil conditions in different parts of Barbados, would naturally be profoundly altered. Eventually the factors connected with the topographical irregularities of the land-surface, and with the nature of the soil in the various parts of the Island, would begin more effectively to operate, and the re-association of plants to suit the new conditions of growth would be initiated.

When new plants were imported into the Island by the early settlers, another disturbing factor of great moment was introduced either consciously or unconsciously. Many of the imported plants have escaped from direct control so that they now enter into the composition of certain natural plant associations. Thus we should be safe in saying that the most important factor which has been instrumental in bringing about in the flora of Barbados the profound changes which have gone on since man first started his activities in the Island, is the factor which man's presence has itself introduced

PART II.

THE PLANTS OF BARBADOS.

CHAPTER VII.

CLASSIFICATION OF THE VEGETATION OF BARBADOS.

The present-day vegetation of Barbados may be divided into two more or less distinct classes according to the degree in which their distribution and mode of occurrence have been influenced by man. The first division includes those plants that are found grouped together in *natural plant communities* and which have come to be so arranged chiefly as the result of the "sifting effect" of agents such as the climatic, topographical and soil factors described in the last part. The plant communities implied by this statement occur in districts where man's influence has not, to any appreciable extent, been felt. It is worthy of note that a number of the plants forming these natural communities are introduced plants, that is, they have been brought into the Island, consciously or unconsciously, by man. They are, nevertheless, perfectly established in the different plant communities, (probably by reason of the remoteness of their date of importation), and do not materially alter the general nature of the question of distribution. Wherever an introduced plant is mentioned in a subsequent description of a region of vegetation, a statement of the fact will be made, so that the truth of the above remarks may be tested.

In Barbados, the districts in which the plant population consists of a natural plant community are of small area but are nevertheless of varied nature. Examples of them may be found in sea shore districts, rocky waste places, gullies, certain waysides and perhaps ponds. If the plant communities of such regions as these be examined in turn, it will be noticed that in certain cases the community is made up of plants of one general type, whereas in other cases, it may consist of two or more types intermixed. In other words, the plant community may consist of one or of more than one "pure" plant association. Take as an instance almost any example of the rocky waste places that occur on many estates in the upland parts of Barbados. It will be found that a certain set of plants grows on the bare rock itself (being rooted in the crevices and channels in the rock), while another set of plants grows in the shallow soil which occurs between the rocks or in pockets and hollows in their surfaces. The plants of the first set are erect, scrubby plants, able to live even under the severe dry conditions of their rocky habitat, whereas those of the second set are small pros-

trate herbs which are able to thrive only where a certain amount of soil covers the rocky substratum. We have here, then, two "pure" plant associations inhabiting different sub-regions of rocky waste land, and we may term the vegetation of such a district a "mixed" vegetation consisting of two pure plant associations.

It is therefore proposed to deal with the plants of Barbados which are grouped together in undisturbed regions, under the headings "Pure Plant Associations" and "Mixed Plant Communities." Typical districts where a single "pure" association occurs will, as far as possible, be chosen and described, so that the features of the plants established under one set of growth conditions may be learned, and the relation between these features and the factors at work in the environment may be understood.

The second division of Barbados plants includes those plants that are found either only occasionally in groups, or in entirely isolated positions, and whose arrangement and mode of occurrence are, to a greater or lesser degree, due to man's influence in so far as he has unconsciously or consciously determined the nature of the environment in which the plants are now found to be living. Here again these plants may be subdivided into several groups as the following statement will indicate. Consider as an example the weed vegetation of a cane-field. As will be pointed out in detail in another chapter, this consists of certain plants which are able to persist in spite of the operations of tilling and weeding, and in spite of the fact that the sugar cane plants themselves exert some influence on other plants growing in their vicinity. Cane field weed vegetation, therefore, constitutes an association of plants whose nature has been decided in part by the unconscious influence of human agency. Next consider the case of the plants that populate many roadside gutters or trenches. These plants live in a habitat whose features have been partly decided by man. The depth of the soil, the liability of that soil to receive much or little water during rainy weather, and so on, are all decided, again unconsciously, by man. Further, the regularly repeated operation of weeding or cleaning roadside gutters restricts the growth of certain kinds of plants which will therefore never characterise such a habitat. The plants of cane fields and of certain roadsides may be consequently grouped together as associations of plants which owe certain of their features to human influence. They may be termed "artificial plant associations."

Finally, there are, in Barbados, plants such as shade trees, fruit trees and ornamental trees, which grow in habitats more or less suited to them, but often decided by man, who establishes specimens of these trees wheresoever he desires. Occasionally these plants may be self-sown and may become fixed eventually as regular members of some plant association, but such occurrences are rare. Plants cultivated for food and plants grown in gardens for their beauty of flower or form, are other examples of plants which occur in habitats decided for them by man. According to the peculiar features exhibited by the plant population of Barbados it would be advisable, for the sake of clearness and in order to avoid a possible misunderstanding of the nature of the botanical problems presented by the flora of the Island, to adopt some such classification as that outlined above.

In order to make clear the relationships between the various classes of plants it would also be advisable to tabulate the classes before proceeding to a consideration of each in turn.

DIVISION A. *Plants of Natural Plant-Communities whose features have been little influenced directly by man.*

(I) *Pure Plant-Associations.*

(II) *Mixed Plant-Communities* (consisting of two or more "pure" associations).

DIVISION B. *Plants whose distribution, arrangement or mode of occurrence have been largely influenced by man.*

(I) *"Artificial" Plant Associations.*

(II) *Plants occurring in no ecological grouping* (including Trees which occur in more or less isolated situations, cultivated Crops and Garden Plants).

DIVISION A.—THE NATURAL PLANT COMMUNITIES OF BARBADOS.

SECTION I. THE PURE PLANT ASSOCIATIONS.

CHAPTER VIII.

CLASSIFICATION OF THE PURE PLANT ASSOCIATIONS.

In this section it is intended to deal with several well-defined plant associations which are to be found occupying certain regions of Barbados in each of which the conditions governing the growth of plants are more or less uniform. Although the actual area occupied by the plants of pure associations in the Island is small (being about ⅙ of the total area), yet there occur in it districts where one or other of the pure plant associations are sufficiently typical that an observant student is easily able to obtain first-hand knowledge of some of the fundamental principles of Ecological Botany by a careful investigation of them.

In attempting to classify plant associations according to the relations between the botanical features and the conditions of growth in the environment, one recalls to mind at the very outset the fact that certain plants are able to grow in water and others on land. This at once suggests a division of plant-types into aquatic and terrestrial. At the same time, it hints at the importance of water as a decisive factor in determining the limits of plant associations, and causes one to enquire closely into the effect of the different soil factors on the distribution of plants within a particular climatic vegetation zone. Careful investigations have shown that *the influence of soil factors in determining the development of definite natural plant communities over a limited area is undoubtedly of major importance, and that of all the natural factors which act within the soil, the factor of water supply is the most potent.*

In spite of the great difficulty in arranging plant-associations into comprehensive groups (chiefly by reason of our lack of detailed knowledge of the relative importance of soil factors), it is generally agreed that the simplest and most satisfactory grouping is that based on the *water relation* of plants. According to this commonly accepted scheme, plants are divided into Hydrophytes, Mesophytes and Xerophytes.

(I.) HYDROPHYTES. This name means "*Water Plants.*" Plants of this ecological division grow in situations in which the water supply is extremely abundant. They may live totally submerged in water or in soil which is very wet.

Sub-divisions.

(A) *TRUE HYDROPHYTES.* These plants live under conditions very favourable to vegetative activity. The water in their habitat is not saline to such an extent that absorption by their roots

is prohibited, nor is its temperature too low effectively to minimise absorption.

The sub-division includes the following plant associations.

(1) *Free-swimming or free-floating hydrophytes.*
(2) *Anchored hydrophytes.*
(3) *Swamp hydrophytes of pond margins, &c.*

(B) *XEROPHYTIC HYDROPHYTES.* These plants live under conditions generally unfavourable to vegetative activity. Although abundant water occurs in their habitat, yet it contains such a high percentage of dissolved salts, or its temperature is so low, that water absorption is checked, and the plants succeed only by being so constructed that loss of water by transpiration is almost a minimum.

The sub-division includes in Barbados the following plant associations:—

(1) *Sedge-swamp plants* (Sedges, &c.)
(2) *Mangrove-swamp plants.*

(II.) MESOPHYTES. This name means "Middle Plants." Plants of this division live under medium conditions of water supply. They include the majority of plants, and they show every gradation between Hydrophytes on the one hand and Xerophytes on the other.

Sub-divisions—The following are the chief Mesophytic plant-associations of Barbados:—

(A) *MESOPHYTES OF GULLIES.* These plants live under various conditions of soil, such as are naturally presented by the different regions of a gully floor. They include herbs, shrubs and trees.

(B) *GRASS AND HERB MESOPHYTES OF DRY PASTURES.* (Grasses are botanically speaking herbs, but it is convenient to distinguish between grassy plants and the common herb forms on the grounds of their general differences in vegetative habit).

(C) *WOODY MESOPHYTES OF THE FORESTS.*

(III) XEROPHYTES. This name means "drought plants." Plants of this division are exposed to dry soil and dry atmosphere.

Sub-divisions.

(A) *PSAMMOPHYTES* or sand plants. These plants live on a sandy substratum in which the water supply is very scanty owing chiefly to the physical properties of the medium in which they grow.

The sub-division includes in Barbados the following plant associations:—

(1) *Beach plants.*
(2) *Sand-dune plants.*
(3) *Sandy-field plants.*
(4) *Sandy-bushland plants.*

(B) *LITHOPHYTES* or "rock plants." These plants live on exposed rock surfaces where soil is very scanty or altogether absent.

The sub-division includes in Barbados the following plant associations:—

(1) *Plants of sea-cliffs.* (Sea-cliff Halophytes).
(2) *Plants of rocky land.*
(3) *Plants of vertical rocky walls.* (Such as occur in gullies in Barbados).

It is proposed to consider first the Xerophytic plant associations of Barbados. The vegetation of a district where the particular association is best developed will be described, prefaced by notes on the peculiar conditions of the habitat in which that vegetation is growing. Examples of plants most characteristic of the association will then be given, with a short description of certain of them.

THE XEROPHYTE ASSOCIATIONS OF BARBADOS.

CHAPTER IX.

(A) PSAMMOPHYTES (or Sand Plants).

(1) BEACH PLANTS

The locality chosen to illustrate the chief features of a Barbados sandy-beach pure plant association is situated on Maxwell coast in the south of the Island between the spit of and to the east of Chalis and Nova Lisboa. Its length, measured along the curving sea margin, is about 500 yards, and its width measured from the high water mark to the zone of artificially planted trees bordering its landward side, is about 150 yards. This strip of coastland is comparatively newly formed. Up to about thirteen years ago there was little or no beach here at all. Nowadays the sea never encroaches on the land, the surface of the ground being on the average some four feet above sea level, and rising to this height quickly from high water mark.

Along the sea border between the tide marks (which are here about ten yards apart), there is no sign of active vegetation, but only sea weeds littered here and there in varying stages of decay. Sea weeds, with few exceptions, require a fixed substratum, and this is not to be found in the moving sand of a wave-washed beach. At very low tide however, rocks are exposed below the low tide mark in this district, and these rocks are found to be covered by sea weeds of many forms and colours. The sea weeds constitute a Marine Hydrophyte Association and differ widely from land plants in their characters of outline, of function and of propagation. They belong to a botanical class of plants known as Algæ, and will be described in more detail when the Hydrophyte plant associations are considered. Turning our attention to the belt of sand which forms the main part of the area, we find here a plant association of a very distinctive type, growing in a substratum in which little or no organic matter is present. The water supply of the plants is mainly that which is brought up from the lower layers of saturated sand by capillary attraction. If one digs a hole anywhere in this region, one especially comes down to the moist under layers, and if the hole be sufficiently deep, water will ooze into it and will in time attain a constant level which corresponds to the level of saturation or "water table" in the sandy substratum.

Excavations made in this way in early May 1917, towards the end of a continuously dry period of about two months duration, gave the following results:—

	Distance of hole from high water mark	Depth of "water table" below *ground* level	Depth of "water table below *sea* level
1	8 yards	2½ feet	½ foot
2	50 „	5½ „	2½ feet
3	150 „	6½ „	2 „

The measurements are approximate only, for the sandy ground is very uneven. The results indicate that the maximum depth of the water table below ground level in this region is about 5 feet. In the wet season the level of the water table is perhaps somewhat nearer the ground surface, but no actual measurements are on record.

The water which collects in holes made in the sand is remarkably pure. At the time when the observations were made, samples of soil water were taken, and their salinities estimated. The following results were obtained:—

Distance of hole from high water mark.	Parts by weight of dissolved substances per 100,000 parts by weight of water.	Percentage of organic matter in the dissolved substances.
50 yards	48 parts	none
150 „	24 „	trace
For comparison		
Sea water	4,355 parts	none

It is quite clear that the limiting factor governing the growth of plants in the habitat under consideration is the availability of water at the roots of the plants. The material of which the substratum is composed is coarse, loose, white, coral sand. Its texture is such that it is very porous, almost non-retentive of water and of low capillarity. It is, therefore, "warm" and dry, and the movement of water from the moist lower layers is slow and its amount almost negligible, the topmost layer of all being especially devoid of water.

The means by which the under layers of the substratum become charged with water are of two kinds. First, rain falls on the land in the wet months of the year and is absorbed by the porous sand. Much of it undoubtedly gets away to the sea by underground lateral movement, but the lower layers of sand, along with the underlying coral rock, probably permanently retain some of the rain water. Secondly, water reaches the substratum by seepage from the inland line of limestone cliffs which borders the district to the north. The most conspicuous line of cliffs lies at a distance of about ¾ mile from the sea coast, and is of average height 40 feet. From the base of the cliffs, the land extends seawards in a flat cultivated expanse until it reaches a low ledge of rock of height about 6 feet, which immediately borders the sandy tract. Undoubtedly the porous coral rock of which the terraces ending at the two cliffs faces (the first of considerable height and the second, low) are composed, stores up a considerable amount of water in the wet season and lets it out again gradually, as a series of underground springs and as seepage water, into the low-lying sandy beach. That such a letting out of

water from inland cliffs of this sort is continuously going on here and in other localities in Barbados, is indicated by the presence of springs of fresh water in many places along the coast of the coralline region of the Island. These springs frequently rise upwards out of the sand just below low water mark and are of sufficient magnitude to cause the water near the land to be cool and of small salinity. A typical example occurs at Freshwater Bay.

From the above account it will be gathered that any plants which manage to thrive in the habitat presented by a sandy beach live under conditions of severe drought and of intense light. We should therefore expect that their characteristics suit them to live under such conditions, and it would be best to study at once the flora of the beach in order to find out what are the xerophytic features of sand plants of sea beaches.

Our first observation of the nature of the vegetation of the district under consideration is that it is by no means dense. It is an open association. Secondly, the plants themselves are chiefly low creeping herbs, or small erect herbs and shrubs. A few fairly tall shrubs or bushes occur scattered about, especially in the region of the beach most remote from the sea. The creeping plants consist exclusively of the conspicuous Goat's-foot Ipomaea (*Ipomaea biloba*) and the stout- stemmed Binding Grass (*Paspalum distichum*). The erect herbs include the milky, small-leaved Seaside Spurge (*Euphorbia buxifolia*); a grass-like tufted plant (*Mariscus brizeus*); and a tufted grass (*Paspalum sp.* (*? caespitosum*). The shrub which occurs in conspicuous grey clumps of all sizes in every part of the area is the Seaside Lavender or Crab Bush (*Tournefortia gnaphalodes*). It is a typical sea-beach plant and is worthy of special study. Of the shrubs that occur here and there in the hinder parts of the sandy region, the common Sea Grape (*Coccoloba uvifera*); the Horse Nicker (*Guilandina bonducella*); the Spanish Needle (*Yucca aloifolia*); and a few specimens of the Maypole Bush (*Agave americana*) are the only plants of importance. It is not certain, however, whether or no the two last-named plants belong to the natural vegetation of the region, for many individuals of these species have been planted artificially from time to time in order to reclaim the sandy land as it was forsaken by the sea. There is one shrubby plant whose presence in the back part of the sandy zone is perhaps due to natural causes; it is the common pink flowered Sage (*Lantana involucrata*), especially abundant in rocky districts of Barbados. This plant will be described when the vegetation of such rocky districts is considered. Finally, many rather stunted specimens of the blue flowered Vervain (*Stachytarpheta indica*) occur in the more inland parts of the sandy zone. The Vervain is a very common plant in other more favourable habitats in Barbados, and will be described elsewhere.

DESCRIPTION OF THE MORE COMMON AND TYPICAL SANDY-BEACH PLANTS.

1. *Tournefortia gnaphalodes.* (Boraginaceae) Seaside Lavender

An erect shrubby plant of height up to 3 feet. The much-branched lower parts of the plant possess black, shiny bark, but the young twigs the leaves and the inflorescence-stalks are covered with a fine silvery down. The leaves are about 2 inches long, and narrow. They are stalkless and are arranged in close bunches at the ends of the twigs. They lose a minimum of water by transpiration, chiefly by reason of the protecting effect of the covering hairs. Water is stored up in the

succeulent tissues of the slightly fleshy leaf, this feature, as well as the presence of the hairs, being a typical xerophytic adaptation. The root system of the plant is extensive. The flowers and fruits are arranged in a "one sided cyme."

2. *Ipomaea biloba* (*pes-caprae*) (Convolvulaceae) Goat's-foot Ipomaea.
A perennial creeping plant with very long, thick, herbaceous trailing stems, which are attached here and there to the sand by long slender roots which spring from the places where the leaves are attached (i.e. from the nodes). The herbaceous stems are usually joined on to a thick stout root-stock, which is very deep-growing and much-branched. By reason of this the plant is able to obtain water from the moist under layers of the substratum when once it is established. This fact accounts for the luxuriance of growth and fresh greenness of appearance of Goat's-Foot. The leaves are shiny, leathery, and shaped like the base of a cloven hoof. Their structure (especially the presence of a resistant water-proofing shiny layer of cuticle on both surfaces) is such that the plant loses litte water by transpiration, so that no waste is made of the water absorbed. This feature enables the young plants (which take in water only by their fibrous roots attached to the stem) to thrive in the loose sand until the root stock develops. The flower of the Goat's foot is bell-shaped and of a purplish colour. The fruit is a brittle capsule which contains usually four smooth seeds.

3. *Euphorbia buxifolia* (Euphorbiaceae) Seaside Spurge.
An erect, shrubby plant of height about 2 feet. The leaves are small (which reduces the surface area from which water may be lost by transpiration). They lie close to one another and to the stem which shades them somewhat from direct sunlight. They possess smooth, thick, waxy skins and contain a milky juice. This juice is harder to evaporate than pure water, and may be considered as a special xerophytic feature of the plant. The tiny inconspicuous flowers and small spherical capsules are borne in large numbers in the leaf axils on the upper parts of the branches.

4. *Mariscus brizaeus* (*Cyperus ottonis*) (Cyperaceae) Sand Sedge.
A perennial, grass-like, tufted plant with long, narrow, stiff, rough leaves. These often grow to a length of 2 or 3 feet. A long, stout, green, central stalk bears brown clusters of minute flowers which occur in the axils of 3 or more long, horizontal, leaf-like bracts.

5. *Paspalum distichum* (Binding Grass)
Described under Sand dune plants.

6. *Coccoloba uvifera* (Seaside Grape or Sea-grape)
Described under Sand dune plants.

7. *Lantana involucrata* (White Sage).
Described under Rock plants.

(2) SAND-DUNE PLANTS

The most perfect development of a sand dune plant association in Barbados is to be found near Long Pond (Belle Plaine) in the Scotland District. This will be taken as a type-example therefore, and will be described in some detail. At Belle Plaine (as the alluvial flat over which flow the two chief watercourses of the Scotland District is called), the rivers unite and flow seawards at a point near St. Andrew's Church. The water does not here enter the sea by any definite estuary, but in consequence of the waves having thrown up a barrier of sand across the mouth of the water course, the river bends round and forms an elongated expanse of water (called Long Pond), which runs parallel to the shore and at no great distance from the sea margin. It is near Long Pond that the sand-dunes occur. These dunes extend for a distance of one mile north of the pond and also form several low ridges between it and the river. They have been formed by the accumulation of wind-blown material transported from the sea-shore, which constantly receives large deposits of sand by reason of the peculiar inwash of the currents along the coast of this part of the Island. The sand of the beach and of the dunes of the Scotland District differs from the sand of the beaches of other regions of Barbados in that it is composed chiefly of siliceous and not of calcareous material. It resembles calcareous sand, however, in the comparatively large size of the individual grains of which it is constituted.

Let us now consider the sand-dunes of the Long Pond district in connection with the plant population which they support. Nearest the sea, the dunes are small and but sparsely covered with vegetation. They are typical "white dunes", and their initiation may be seen going on in those places where tufts of shore plants have arrested the onward motion of the wind-blown sand. The chief plants which play the part of obstacles in this connection are the Binding Grass and the Seaside Spurge. The former possesses long profusely-branched stems, which run over the sand or just below its surface, and spread often almost down to the high water mark. The stems frequently become buried by the loose sand, and thus take on the characteristics of persistent underground stems or rhizomes. They give rise at intervals to upward growing shoots which protrude above the level of the substratum, the line of the underground parts being marked out by the rows of subaerial shoots springing from them. The numerous and exceedingly long roots of the plant permeate the loose sand in abundance and bind its grains together. The shoots possess the remarkable power of growing upwards through any loose sand that collects round them. This faculty of enduring temporary burial is the chief characteristic of the Binding Grass which renders it such an efficient dune builder. In the interior of the old dunes broken down by wind or other means, one finds a great number of old rhizomes and roots of this plant, which thus indicate the important part played by the grass in accumulating fresh stores of sand. The Seaside Spurge (which has already been described) is able to colonise bare and shifting sand, probably by reason of the quick growth and deeply rooting habit of its seedlings. Small tufts of this plant occupy isolated positions often quite close to the sea margin. They are capable of quick growth, so that, to a limited extent, they can keep their leafy shoot-tips above the surface of the sand, and thus, like the Binding Grass, materially aid in the building up of the dunes. After the dunes have reached the height of a few feet, however, the Spurge plants usually end by being buried, but fresh individuals may be established on the surface of the sand heap, and so the process of accumulation may go on.

Once the dunes have been started and the mobility of the sand destroyed, it is a comparatively easy matter for certain other plants to gain a foothold on the substratum. On the Long Pond dunes the Goat's-Foot Ipomaea is the most conspicuous of such plants. Its long trailing stems are to be seen on the "fixed" dunes forming often a close network held down firmly to the sand by the long fibrous roots. An unidentified grass which possesses short, flattened, broad leaves arranged alternately at angles to the stem axis, and whose long stems trail over (and not through) the sand, is also a very common sand binder, its roots penetrating the substratum to a great depth. Occasionally on the lower slopes of the dunes (especially on their seaward sides where salty water saturates the sand), certain true succulent halophytes occur. The Seaside Samphire (*Sesuvium*), and a species of *Iresine* (to be described as rock halophytes in a later chapter), are the most common plants of this type, often occurring in abundance on or near the sand-dunes. Another plant which is to some extent succulent is the Wild Lavender (*Heliotropium eurassavicum*), whose small waxy leaves exhibit a blue sheen when the full sunlight shines on them.

The older and larger fixed dunes support a vegetation which is chiefly grassy. The sandy surface becomes covered by a sod consisting of low prostrate herbs, which, on decay, enrich the substratum in humus and thus gradually make the conditions more favourable for plant growth. Dunes clothed with vegetation of this sort show no white, sandy, bare patches, and are therefore termed "grey dunes". The plants of the grey dunes of the Long Pond district are chiefly the unidentified flat trailing grass mentioned above, the Egyptian Grass (*Eleusine aegyptiaca*); a short, fine, dark, greenish grass (*Eragrostis purshii*); the Burr Grass (*Cenchrus echinatus*); the Goat's-foot Ipomaea; *Lippia reptans* and the Duck Weed (*Pectis humifusa*); the two latter forming mats on the sandy surface.

The Binding Grass and the Spurge are usually absent on the grey dunes. They have succumbed in the end after a long struggle with the conditions of life enforced by the shifting sand, and have prepared the ground for the establishment of other more fixed types of plants whose mode of growth does not fit them for populating a loose and shifting substratum.

On many of the grey dunes, especially on those that occur farthest away from the sea margin, numerous and conspicuous shrubs have become established. Of them the dominant species is the Sea Grape (*Coccoloba uvifera*). The long roots of this plant, in places where part of a dune has been broken away by the undermining action of the river, may be seen to reach right down to the bottom of the dune, and actually to penetrate the surface of the alluvial flat beneath it. The Sea Grape is a typical sand plant, and its seedlings, by reason of their quick-growing tap roots, are able rapidly to establish themselves on any substratum containing a modicum of organic matter and of moisture. Along with the Sea Grape, the striking French Cotton plant (*Calotropis procera*) is of frequent occurrence, and occasionally also, the Manchineel (*Hippomane mancinella*); Horse Nicker (*Guilandina bonducella*); Seaside Sage (*Croton flavens*), and the Fat Pork (*Chrysobalanus icaco*).

Behind the dunes, stretches of fixed sand covered by an association of "sandy-field" plants extend inland for a distance of some 300 yards, (especially to the north side of the river), where the ground rises gradually to a ridge of hills of height about 250 feet, which bears a covering of drift sand for almost

half the way up its slopes. To the south of the river, this sandy field soon gives place to cultivated land which merges into the cane fields of Belle Plaine.

DESCRIPTION OF THE MORE COMMON AND TYPICAL SAND DUNE PLANTS.

1. *Paspalum distichum* (Gramineae) Binding Grass.
A perennial grass with long stems which are usually underground and persistent. These underground stems put out vertical leafy shoots at intervals, and are anchored in the sand by long roots. The inflorescence consists of two short broad spikes of tiny flowers, attached in a V shaped fashion to the end of the inflorescence-stalk. The Binding Grass is common in dry pastures, swampy ground, and in other widely-differing habitats. It is sometimes mistaken for the Devil's Grass, especially in those habitats where the underground stems are not typically developed, the plant then taking on the characteristics of a soft, leafy, trailing grass. The leaves of the sandy-beach and dune-form, are tough, and possess a resistant covering layer which enables the plant to resist desiccation.

2. *Lippia reptans* (Verbenaceae). No common name.
A woody herb with much branched trailing stems closely adpressed to the substratum, and firmly held there by numerous roots which spring out from the nodes (i.e the point of attachment of the leaves). The leaves are small, of a dark greyish green colour and fairly thick, with a slight inclination towards succulence. The leaf surface is protected by a leathery outer layer. The tiny flowers are borne in roundish heads.

3. *Pectis humifusa* (Compositae) Duck Weed.
A flat growing plant with woody base and very numerous, crowded, small, bright-green leaves. The whole plant forms a plate-like cushion (or "mat") which can be pulled away bodily from the substratum. The mat habit is an important and characteristic feature of plants such as the Duck Weed, for closely-growing leaves pressed tightly on to the surface of the ground keep in the moisture of the upper layers of the substratum, which they protect from the direct rays of the sun. They also save loss of moisture by transpiration because they are spread in the more humid layers of air which occur near the ground surface. Finally, mat plants accumulate humus from their dead leaves and form flat spongy masses which retain water from dew and rain, and also conserve the materials absorbed by the plants during growth.

4. *Coccoloba uvifera* (Polygonaceae) Seaside Grape or Sea Grape.
This common woody shrub is too well known to require minute description. It exhibits xerophytic characters in the structure of its tough leathery leaves, which are furthermore arranged in two ranks, so that the lowermost leaves on the long straight stems are shaded from the direct rays of the sun by the upper leaves. The flowers of the Sea Grape are borne in racemes, and the fruit is a hard-stoned drupe.

5. *Calotropis procera* (Asclepiadaceae) French Cotton.

An erect woody plant containing a milky juice. The sparsely branched stems (which often reach a height of 6 feet or more) bear flat leaves in two ranks. The leaves are inclined upwards and mutual shading occurs. The leaf surface (and also that of the young stems) are covered with a conspicuous "bloom" of wax. The arrangement of the leaves, the presence of milky juice, and the waxy layer are all xerophytic features which enable the French Cotton to live successfully in a dry sandy substratum. The flowers are of peculiar structure and the fruit is a swollen bladder-like object which encloses numerous neatly packed seeds. The seed is provided with a tuft of long silky hairs by the aid of which it is disseminated by wind on the decay of the fruit.

6. *Sesuvium portulacastrum* (Seaside Samphire)
Described under "Sea Cliff Halophytes"

7. *Iresine portulacoides.*
Described under "Sea Cliff Halophytes"

8. *Heliotropium curassavicum* (Wild Lavender)
Described under "Sea Cliff Halophytes"

9. *Croton flavens* (Seaside Sage)
Described under "Plants of rocky land".

(3) SANDY-FIELD PLANTS

The association of plants grouped under this title is not at the present day well defined in Barbados. It is meant to include the plants that inhabit the sandy soil immediately backing the expanses of pure sand which border the coast in many regions some distance inland from the grey dunes described above, and consists of grey dune plants such as *Lippia reptans*, *Pectis humifusa* and often the Binding Grass (*Paspalum distichum*), along with a few erect herbs such as those mentioned below. Near Bridgetown on the coastal strip which lies between the Engineer's Pier and Needham's Point, the sand-field plants consist chiefly of the West Indian Tea (*Capraria biflora*); the Vervain (*Stachytarpheta indica*); one or two species of grass; the leguminous Indigo Bush (*Indigofera tinctoria*), and the Wild Coffee (*Clerodendron aculeatum*).

On the whole, the plants of this ill-defined association are somewhat xerophytic and hardy. They live in a substratum which contains some organic matter but which is mainly sandy, and therefore dry and warm. In most regions the association merges on the one hand into the true sandy-beach association and on the other, into the belt of sandy-bushland which marks the landward limit of the low lying coast in those districts where no sea-cliffs occur.

(4) SANDY-BUSHLAND PLANTS (Coccoloba Association)

Many of the sandy beaches of Barbados possess an association of small trees

and bushes which succeeds the low-growing vegetation (when this is developed) on its landward side. At the present day this association is nowhere of any great extent, but it is sufficiently distinctive and common to deserve mention. It may be termed the "Coccoloba Association" because the dominant plant in it is the Sea Grape (see page 229, Warming. Bibliography No. 8). In former times it may have extended for a considerable distance inland in many of the lowlying coastal regions of the Island, judging by the occurrence of isolated specimens of several of its common members in places which, although nowadays surrounded by cultivated land, must once have been unfitted for the growth of all but certain plants of a specialized kind.

The most typical area in Barbados in which the Coccoloba Association is to be found, is on the south coast of the Island below St. Ann's Fort at the Garrison. This area in question is partly Government land and partly a section of Mr. Craig's land. Although its features have been somewhat altered by the artificial planting of certain trees, it still retains many of the characteristics of a natural planting association. The land is low-lying, extending backwards from the sandy beach (which possesses a psammophytic vegetation very much like that already described) to a steeply rising rocky cliff of height some 20 feet, situated at a distance of about 200 yards from the sea margin. Immediately to the west of the area lies a small expanse of marshy land populated by sedge, and to the east of it, the low rocky cliff comes forward until it borders the sea, meeting the water at a point some 500 yards east of the marsh, and thus forming the boundary of the area on two sides. The substratum in which the trees and shrubs are growing is almost pure sand. There is a little organic matter in it, the amount of this approximating 1.3% as determined by chemical analysis. The level of the ground is three or four feet above sea level in that part of the area which adjoins the sandy beach. Further inland it sinks some what, and then rises gradually to the foot of the cliff at the back. The water table is at a depth of nearly 1 to 1½ feet at the lowest point in the area, distant some 80 yards from the beach. A sample of the water taken from this place and analysed shows that the water supply is not very saline, for it contains less than 0.3% of dissolved solids, of which a quarter is organic matter and the rest almost pure sodium chloride (common salt).

The limiting conditions of plant growth in this region are thus seen to be poorness of soil in nutrient salts, and the presence of a waterlogged under layer of sand which exists at a comparatively small depth below the ground surface, and may, in many places in very wet weather, even coincide with the level of the land itself.

We will now describe the nature of the vegetation which is to be found in this area.

Besides the Sea Grape, low trees or bushes of the following species occur in the Coccoloba Association:—Manchineel (*Hippomane mancinella*); White Wood (*Tecoma leucoxylon*); Seaside Mahoe (*Thespesia populnea*); White Acacia (*Leucaena glauca*); Sweet Briar (*Acacia farnesiana*); Galba (*Calophyllum calaba*); Scarlet Cordia (*Cordia sebestena*); and certain low shrubs such as the Wild Coffee (*Clerodendron aculeatum*); and the liane known as the Soldier Bush (*Tournefortia volubilis*). The herbaceous undergrowth varies somewhat according to the nature of the soil. In the marshy places, certain sedges abound, but in the more sandy regions, the undergrowth plants are of the

same general nature as those of the sandy-field association already described. It may even include certain sandy-beach plants which have migrated from the districts directly bordering the sea. Of special interest is the unique occurrence of a leguminious trailing plant of the general habit of the Goat's foot Ipomaea, Its name is *Canavalia obtusifolia*. This plant possesses large, smooth, tough compound leaves of three leaflets each, and bears racemes of purple pea-like flowers which give rise to long broad pods. *Canavalia* grows on the beach in this locality, and extends well into the sandy soil region of trees which succeeds it. It is uncommon on beaches of Barbados other than the one under consideration, but is extremely prevalent in sea shore associations of certain other West Indian islands and of Eastern Asia and Australia.

Another beach plant which is also nowadays uncommon in Barbados but which is common in other West Indian Islands, found growing on the margin of the sandy bushland area under discussion, is the Seaside Parsley (*Ambrosia crithmifolia* (*hispida*). This is a member of the family Compositae and is characterised by its crinkled leaves. Patches of it occur to the east of the area near Needham's Point Lighthouse.

Examining the botanical characteristics of the trees in the above list of names, we notice that in the case of the White Wood, Galba and Cordia, the leaves are of a xerophytic nature, that is to say, they are more or less protected from excessive loss of moisture by a tough leathery layer or cuticle. In the case of the other trees, however no such well-marked xerophytic feature is noticeable, so that we must find some other explanation for the constant occurrence and apparent adaptation to conditions of the trees of the Coccoloba Association. It is hard to decide which characteristics are of importance in this connection, partly because the state of our knowledge is not sufficient to enable us to arrive at definite conclusions as to the relation between soil conditions and plant form, and partly because no exhaustive examination of the mode of development and the peculiarities of the root systems of the plants in question has yet been undertaken. It is possible that the solution of the problem lies in the nature of the root systems of the trees, for in many cases it is to be remarked that the plants possess abnormally deep and wide spreading roots, that is, where sufficient root room has been available for the unrestricted growth of the under-ground parts of the trees. This feature is well illustrated by the root system of the White Acacia, which is remarkedly adaptable to the varying conditions of water supply occurring in the different regions of the area. The Acacia is a leguminous plant with fine unprotected delicate leaflets, and yet it is able to grow just as well in places where the water supply is small and where the water table is at a considerable distance below ground level, as it is in places where the land is almost marshy. It appears that the plant is able to develop either a long tap-root system or a shallow surface-feeding root system depending on whether the water table lies at a great or at a small depth below ground. A further feature of several of the Coccoloba Association trees is the production of quickly growing deep, tap-rooted seedlings which may be responsible for the establishment of the trees in their peculiar habitat in the first place. Plants with no such vigorous seedlings might be unable to develop rapidly enough to reach the moist regions of the soil before their supply of foodstuffs runs short.

The above suggestions are brought forward simply to indicate the somewhat ignored fact that the features of the root system of a plant may largely decide its success in a habitat not very conducive to the growth of normal plants.

The characteristics described are possessed by almost all the species named above, and this fact alone is sufficient to suggest a probable explanation for the aggregation of these plants into a definite association.

Finally, there also occur in the association of plants of the sandy-soil region under consideration a few species of plants which are known to have been introduced into Barbados by human agency, and in certain cases, to have been actually planted in this particular region within the knowledge of persons acquainted with its history. The Coconut Palm (*Cocos nucifera*) is the commonest of these. This tree thrives fairly well in the peculiar substratum, but the best specimens are to be seen growing where a considerable layer of dry sand overlies the waterlogged regions of the substratum. Another commonly occurring tree is the Barbados Almond (*Terminalia catappa*) which characterises sandy-bushland plant associations in Eastern Asia, but which has apparently found the conditions of growth in this sandy-soil region quite favourable. The fact that the Almond (as well as the other trees of the Coccoloba Association) may be seen here to be reproducing themselves freely from self-sown seeds, indicates that they are entirely adapted to life in this habitat. The case of the Almond is of interest in that it furnishes an example of how a plant not indigenous to a particular country can, on introduction, escape from cultivation and enter into competition with the native plants already constituting a natural plant association.

DESCRIPTION OF CERTAIN PLANTS OF THE COCCOLOBA ASSOCIATION.

1. *Coccoloba uvifera* (Seaside Grape) Already described.

2. *Hippomane mancinella* (Euphorbiaceae) Manchineel.

   A small tree with numerous branches, and usually a short trunk. The leaves are elliptical and of a shining bright green colour. They remain on the tree for a long period without being shed. The tree does not lose all its leaves at once, and is for this reason said to be evergreen or non-deciduous. The plant bears male and female flowers on separate axes, it is therefore styled "monoecious" in distinction to plants which bear male organs on one individual and female on another (dioecious plants). The fruit is a drupe, that is, a fleshy fruit with a hard inner layer immediately enclosing the true seed or seeds. The size, shape and odour of the fruit is similar to that of a small English apple, but it contains (as do also the leaves and stems of the Manchineel) a milky juice of an extremely corrosive and poisonous nature.

3. *Tecoma leucoxylon* (Bignoniaceae) White wood.
   See under "Shade Trees" in Section II.

4. *Cordia sebestena* (Boraginaceae) Scarlet Cordia.
   See under "Flowering Trees" in Section II.

5. *Terminalia catappa* (Combretaceae) Barbados Almond.
   An introduced plant. See under "Shade Trees."

6. *Cocos nucifera* (Palmae) Coconut Palm.

This plant originated probably in the western regions of the Panama Peninsula. It is cultivated in most tropical countries to which it has been brought in the majority of cases by man, although occasionally it may have been distributed by ocean currents which are able to bear away its buoyant and resistant fruits. The Coconut was introduced into Barbados very soon after the date of settlement. It is a tall tree with tortuous stem and very numerous unbranched fibrous roots, which come off from the base of the stem and penetrate the soil in all directions. The root system is therefore said to be "adventitious" rather than of the "tap root" type. The leaves are borne in a large cluster. They are long and pinnate, that is, each consists of great numbers of leaflets. The coconut palm can withstand intense sunlight because its leaves are set edgewise to the sun's rays, and the leaflets are protected by a leathery shiny cuticle. The flowers are borne in abundance in a dense inflorescence which is subtended by a large woody bract. They are monoecious. The fruit is a one-seeded drupe of which the outer layer is shiny, green and leathery, merging into the middle layer of fibre which surrounds the innermost hard stony layer, immediately enclosing the hollow seed. The seed has a thin, brown papery covering (or testa) and contains, when young, a sugary juice. The embryo is small and is situated under one of the "eyes" of the "nut." The different parts of the cocoonut are used in various ways as food (desiccated coconut, coconut oil, &c.), or for making household articles (mats, baskets, brooms, &c.). The vegetative features of the plant are such that it can grow successfully in sandy soil near the sea, and in situations in which the sunlight is intense. The xerophytic character of its leaves enables it to remain uninjured by salty sea breezes, and to minimise loss of water by transpiration.

NOTES ON THE VEGETATION OF OTHER SEA SHORE DISTRICTS OF BARBADOS.

(1.) Coconut Walk (near Inch Marlow, 1 mile N.E. of South Point, Christ Church).

A flat stretch of sandy beach of length some 400 yards lining a small bay, here changes into a dune region as it is followed northeastwards. The sandy beach region is very narrow, and exhibits a flora consisting chiefly of Seaside Spurge and Binding Grass. These plants also occur on the dunes, which are clothed with these and other plants so that little of their surface is left uncovered. The dunes are grey dunes. The commonest plants on them are Goat's foot Ipomaea and the grey scrubby Seaside Lavender (*Tournefortia gnaphalodes*. The Seaside Sedge (*Mariscus*), the Duck Weed (*Pectis*) and the White Sage (*Lantana*) are all present.

Immediately behind the sandy beach, a narrow strip of Manchineel, Sea Grape, Lavender, Horse Nicker, French Cotton, Century or Maypole Bush and Spanish Needle (Sandy-bushland plants) occur. Backing the dunes is a low, flat, bare sandy expanse (Coconut Walk) in which numerous coconut palms are growing. Several of these plants occur on the very edge of the dunes and seem to be partly buried by the sand, which cannot therefore have completely lost its mobility.

(2.) Chancery Lane, Christ Church.

Here a long strip of dune-land some 60 yards broad, and situated at a distance of about 10 yards from the sea margin, exhibits a vegetation of grey dune type. The Seaside Lavender occurs plentifully on the tops of the sand hills, and a close network of Goat's-foot stems covers their slopes. Other members of the sandy beach and dune plant associations also occur in less conspicuous array, and at the back of the hills on their landward side, Sea Grape is abundant. A few Coconut Palms are growing on the flat land behind the dunes, and here also an undergrowth of Vervain (*Stachytarpheta indica*) occurs.

The swamp itself supports an example of a plant which is able to thrive very successfully in a sandy substratum containing much saline water. In those parts of the swamp where the brackish water has been temporarily or permanently drained away, a striking bright green carpet of the succulent halophyte—*Iresine portulacoides*, completely covers the surface of the substratum. *Iresine* will be described in the next chapter, since it is also commonly found on rocks as a lithophytic halophyte. Occasionally another succulent halophyte, the wax-coated Wild Lavender (*Heliotropium curassavicum*) accompanies *Iresine* on the swampy sand.

(3.) Foul Bay, the Crane Beach and Long Bay Beach, St. Philip's Parish.

In these three localities, the sea shore vegetation consists of a zone of poorly developed sandy-beach plants backed by patches of sandy-dune bushland, consisting chiefly of Sea Grape and Manchineel. Here and there Coconut Palms occur. The vertical cliff which rises from the shore to a height of some 40 or 50 feet terminates the flat rocky land which borders the coast in this part of the Island.

(4.) The Scotland District Coast.

The sandy-beach vegetation here is not very different from that of other places in Barbados. The beach has an average width of 20 yards, and supports a fairly characteristic assemblage of sandy-beach plants, consisting chiefly of Binding Grass, Goat's foot and Seaside Spurge. North of Round Rock, and between it and Long Pond, a strip of low, grey dune-land of width some 30 yards, immediately borders the railway line. On the landward slopes of the dunes a grassy vegetation occurs. The duneless parts of the shore to the south possess a poorly represented vegetation of the sandy-bushland type, consisting almost entirely of clumps of Sea Grape. Occasionally indications of grassy sand-field vegetation are to be seen here and there, and less frequently, small areas of salt-marsh Sedge.

(5.) Leeward Coast of Barbados.

The narrow beach which lines the coast for most of the distance between Harrison's Point and Bridgetown is at the present day notably devoid of sandy-beach vegetation. The bare stretch of sand between the tide marks is succeeded almost immediately by a narrow zone of sandy bushland of which the Manchineel and the Sea-Grape are the chief representatives. Near

Freshwater Bay, the luxuriance of these trees is especially conspicuous It is possible that in former times the development of the Coccoloba Association in many places along the Leeward Coast was quite extensive, and that alternating with this association of plants, regions of salt-marsh, mangrove swamp and sandy-field plants may have occurred.

(B) LITHOPHYTES (or Rock Plants).

(1) PLANTS OF SEA CLIFFS. (SEA-CLIFF HALOPHYTES).

The habitat presented to plants by the surface of rocks near the sea is, of all habitats, one of the most forbidding and unfavourable. Not only is the substratum composed of hard rock, but the whole situation is exposed to the spray cast up by breakers, and to salty foam and wind which deposit saline matter on rock surface and plant alike. It is therefore not surprising that the flora of sea-cliffs is scanty, and consists only of a few very specialised plants. In order to understand the nature of the adaptations which sea-cliff plants exhibit, it would be well to describe one or two examples.

The commonest and most typical sea-cliff halophyte in Barbados is the Seaside Samphire (*Sesuvium portulacastrum*). This plant is found in all parts of the coast where sea-cliffs occur; it is especially plentiful on the Christ Church coast below Spencers' Estate, and on the coast of St. Lucy's Parish in the north of Barbados.

DESCRIPTION OF THE COMMON SEA-CLIFF HALOPHYTES.

1. *Sesuvium portulacastrum* (Aizoaceae) Seaside Samphire.

The plant hangs in flat masses on the vertical cliffs, or lies on ledges and along the margins of the cliffs in conspicuous red and green expanses. The stems of the plant are prostrate, and often radiate on all sides from a common point which is the place of attachment to the summit of the root system. The roots search out crevices and hollows, or flatten themselves against the rock, so that the plant is firmly held in position. A little organic matter, formed by the decay of leaves collects round the roots, and plays a part in holding up water near them. The leaves of the Samphire are cylindrical and rounded at the extremities. In certain cases they are almost spherical in shape. The average length is ½ to ¼ inch. The young leaves are bright green and the older leaves transparent green passing into red at the tips. Many of the old leaves are entirely red in colour, and are often mistaken for "berries" by casual observers. The leaf tissue is very succulent. This is due to the abundance of cell-sap and to the smallness of the intercellular spaces. The cell-sap is somewhat salty, for the plant absorbs a certain amount of saline matter which is said to be the cause of the thickening of the leaves, and of the partial suppression of some of the green colouring matter (chlorophyll). The presence of much cell-sap probably prevents the salinity of the cell contents from becoming high enough to bring about the poisoning of the plant. (N.B. It is interesting to note in support of this account of the direct effect of salt in producing

a characteristic form and structure of the leaves of a plant, that specimens of the Samphire with leaves flattened and expanded like ordinary green leaves are frequently found growing in Barbados on non-saline substrata. All stages may be traced in the plant between succulence and this latter form of leaf,—indeed the change from one to the other may even be induced artificially in pot culture experiments). The flowers of the Samphire are star shaped, pink in colour, and diameter about ½ inch. The fruit is a small capsule, containing numerous tiny seeds easily spread in drift timber.

2. *Portulaca oleracea* (Portulacaceae) Purslane.

This plant has also two forms, a succulent form on sea-rocks, and a flat-leaf form on the soil of waste sandy places, or of cultivated land. The latter is the commoner. The succulent form possesses translucent pink stems, and fleshy, but somewhat flattened leaves, which are of a pale green colour, often passing into pink at the margins. The flowers of the Purslane are small and yellow in colour. The habit of the plant is very similar to that of the Samphire. The seeds are small, and are easily spread by animals or by drift timber.

3. *Iresine portulacoides* (*Philoxerus vermicularis*) Amarantaceae. No common name.

Here again two forms are known. The seacliff form is however the commoner in this case. Iresine has already been mentioned as a salt-marsh plant in connexion with the vegetation in the region near Chancery Lane, Christ Church. The leaves are succulent, pale yellowish green, and of a globular to elongated-cylindrical shape. The flowers are tiny and membranous. They are borne in large numbers in a straw-coloured cylindrical head of length up to 1½ inches. The habit of the plant is similar to the last.

4. *Heliotropium curassavicum* (Boraginaceae) Wild Lavender.

A woody herb, much branched, and of height 1 to 2 feet. The numerous leaves are small, narrow, stalkless, fleshy, and are covered with a very fine layer of wax, which by reflecting and scattering light, gives the plant a particularly noticeable appearance. The inflorescence is a short one-sided cyme which is curved, and which bears a row of small white flowers. The fruit is a small black structure, consisting of four woody nutlets. The seeds may be spread in drift timber.

5. *Strumpfia maritima* (Rubiaceae) No common name.

This plant is found in abundance on the sea-rocks of the St. Philip coast of Barbados. It is a small shrubby plant, with much-branched woody stems, which are covered with a scaly black bark, and which bear very numerous, green, succulent, but not very thick leaves. The average length of a leaf is about 1 inch. A characteristic feature of the plant is the abundance of small white berries, which succeed the

pale-pink flowers. The leaves of the plant drop off after a time, leaving their scaly stipules attached to the stem. The root system ramifies in the crevices of the rocks, and attaches the plant very firmly to the cliff face.

(2) PLANTS OF ROCKY LAND

There are many waste places in the coralline region of Barbados where the bare rock protrudes above the surface of the ground, and where soil is almost altogether absent, or occurs only in small hollows or pockets. These waste places support a dry scrubby vegetation, which imparts a desolate appearance to the landscape. In certain Antillean Islands such as St. Croix, similar scrubby vegetation covers quite extensive areas, and has been termed the "Crotoneta Association" from the name of one of its comomnest members —Croton (see Egger. Bibliography No. 22). In Barbados there are few places only where this association is typically developed. Perhaps the best representation of it is to be seen on the very edge of the inland cliff which borders the first plateau near Mt. Brevitor Estate in the Parish of St. Peter. At this place, the ground consists almost entirely of bare coral rock, in the crevices of which the plants of the association are rooted. Only a few shallow pockets of soil occur, and these are never of any great extent. To the west of the area towards French Village, the ground is also rocky, but larger expanses of shallow soil interrupt the rockiness. This soil supports a vegetation of the "dry pasture" type (see later), so that at this place the association is of a mixed nature. Returning to the description of the pure Crotoneta Association as developed near Mt. Brevitor, it is to be noticed that, because of the scantiness of the water supply, the plants of the association are of the xerophytic type. They differ markedly however, in general appearance from the xerophytes of sandy districts, as will be seen when certain of the plants are described in detail. The species most common in the association in the region named is perhaps the shrubby red flowered sage (*Lantana camara*). Other plants of similar general appearance are the White Sage (*Lantana involucrata*); the Seaside Sage (*Croton flavens*); and the Black Sage (*Cordia cylindristachya*). The following woody herbs of shrubs also occur:—Wonder of the World (*Bryophyllum calycinum*); the Wild Guava (*Psidium guajava*); the Belly-ache Bush (*Jatropha gossypifolia;*) and the Sickle-leaved Spurge (*Phyllanthus epiphyllanthus*). A few fairly tall bushes or trees of general spiny nature also occur here and there. The commonest of these are:—Black thorn (*Pisonia aculeata*); Sweet Briar (*Acacia farnesiana*); and Cure for All (*Pluchea odorata*).

The majority of these plants are evergreen and woody, with more or less stiff, rough and resistant leaves. Growing amongst them a few plants with fresh, green, glossy foliage stand out conspicuously. Of these, *Chomelia fasiculata* (Rubiaceae is by far the most common, although the Wild Coffee (*Clerodendron aculeatum*) occurs occasionally in this locality, and much more commonly in other rocky districts where the conditions of plant growth are not quite so exacting. Finally, the presence of the attractive ornamental plant, Periwinkle (*Vinca rosea*) (which is in all probability an escape from gardens) in occasional patches in places where a little soil has accumulated, must not be ignored.

On the whole the vegetation is of an "open" character, although on examination, it is seen that, wherever pockets of soil occur, these are populated by collections of small prostrate plants (such as various species of leguminous plants and certain kinds of grasses), which belong to the "dry pasture" type of plant association, to be considered later.

DESCRIPTION OF THE ROCKY-LAND PLANTS.

(N.B. Most of these are extremely common in many localities of Barbados (such as roadsides, waste places, &c.) They are of particular botanical interest because of the adaptation which the plants show to environment. It is therefore intended to give a rather full description of each of them.)

1. *Lantana Camara* (Verbenaceae) Red Sage.

A shrubby plant of height up to 4 feet. The numerous straggling branches bear short spines here and there. The leaves are oval, slightly toothed, and of length up to about 2½ inches. The leaf surface is rough owing to the presence of numerous scaly hairs, which impart a dull appearance to the green colour. The leaves and stems contain an aromatic juice which may in part tend to minimise loss of water by transpiration, although this effect is perhaps negligible. Such aromatic substances in plants are probably only waste products which happen to have a sweet smell. The structure of the leaf, and the presence of the resistant covering on its surface, undoubtedly check transpiration considerably so that the plant is able to live on a dry rocky substratum. The nature of the root system of the plant may, however, be an even more important factor in accounting for the success of the Sage in its peculiar environment. The roots are apparently able to ramify into any crevice, channel or hole, and to derive moisture from the porous interior of the coral rock. One frequently sees specimens of Sage apparently growing straight out from the middle of a lump of bare rock. The flowers of the Red Sage are borne in flat clusters. The young flowers are of a bright, brick-red colour, passing into yellow as they get older. The fruits are small black drupes and are probably carried by birds, which thus bring about the dispersal of the seeds.

2. *Lantana involucrata* (Verbenaceae) White Sage.

A shrubby plant with stiff straight branches which are spineless. The leaves are smaller than in the last species, and possess rounded teeth (crenulate margins). They are greyish-green in colour, and aromatic. The plant possesses similar root characteristics to the last. The flowers are pink in colour, and are subtended by green leaf-like bracts. They occur in clusters, each of which is borne at the end of a straight stalk in the axil of the last four leaves at the end of a branch. The round drupes are purplish-pink in colour and shiny.

3. *Croton flavens* (Euphorbiaceae) Seaside Sage.

This is a low shrubby plant with stiff woody branches. Its leaves are pale greenish-grey when young, turning to a bright saffron or salmon-pink when old. The leaf surface is covered with flat stiff-branched hairs, and the cuticle is tough and thick, so that the plant is xerophytic. The flowers are small and white, and are borne in terminal racemes. The fruit is a small capsule. Any part of the plant when cut exudes a resinous milky juice.

4. *Cordia cylindristachya* (Boraginaceae) Black Sage.

A fairly tall shrub, much branched, with narrowish oval leaves of average length 2 to 3 inches attached to the stems by very short stalks. The leaf is rough and scaly. Its under surface bears numerous small downy hairs. The flowers are borne in terminal racemes. They are small, white and cup-shaped. The fruit (when ripe) is a red drupe of diameter $\frac{3}{8}$ inch.

5. *Bryophyllum calycinum* (Crassulaceae) Wonder of the World.

This peculiar plant is a native of Asia, and was probably introduced by man into Mexico, from whence it has spread (either by natural or human agency) into the West Indian Islands. Its presence, as a well established member of the rocky land plant association of Barbados, is therefore remarkable. It reproduces itself freely in many habitats of the Island, and is found in most localities of rocky waste land. The plant is a woody juicy-stemmed herb, whose long red branches have a somewhat trailing habit. The ends of the branch turn up, however, and bear rows of fleshy oval leaves, the average length of which is about 3 inches. The margin of the leaf is slightly toothed, and from the indentations, rootlets arise when the leaf is detached from the parent plant and placed under moist conditions. These rootlets in time are accompanied by shoots, so that *Bryophyllum* possesses a unique method of vegetative reproduction, which makes it an especially interesting object of study. The thick leaf (covered by leathery cuticle) and the general succulent nature of the plant, show it to be a xerophyte, and to be adapted for life in dry environments. The flowers of *Bryophyllum* are pendant, and are borne in tall racemes. Each is tubular in shape and gives rise to a compound or "aggregate" fruit consisting of four slender, pod-like follicles.

6. *Psidium Guajava* (Myrtaceae) Wild Guava.

A shrubby plant which never reaches a great height in rocky places. It possesses rough leaves. Its flowers give rise to fleshy berries which contain seeds probably dispersed by birds. The Guava in cultivation frequently grows into a tall tree.

7. *Jatropha gossypifolia* (Euphorbiaceae) Belly-ache Bush.

A woody herb with a thick upright main stem and few branches. It grows to a height of about 3 feet. The leaves are deeply incised with 3 to 5 lobes, the young ones reddish black in colour, and the old bright green and shiny. All parts of the plant (except the matured bark-covered stem) bear numerous sticky, glanular hairs. The deep crimson flowers are small, and are borne in terminal cymes. The fruit is a conspicuous oblong capsule of length ¾ inch. It contains three chambers with a large ornamented oily seed in each. The plant is a very common wild plant of waste places, and probably owes its success in dry habitats to its extensive and searching root system, and to its somewhat resistant leaf surface.

8. *Phyllanthus epiphyllanthus* (Euphorbiaceae) Sickle-leaved Spurge.

The common name of this woody plant is derived from the shape of its flat green appendages which, however, are not leaves at all, but transformed stem structures. This we know because they bear tiny flowers and fruits along their margins, and also because they are borne in the axils of scale-like, modified leaves, and therefore have the position of side-branches on the main stems. The Sickle-leaved Spurge is often rooted in crevices of bare rock where soil is almost quite absent. Its very tough, well-protected, leaf-like stems (''phylloclades'') and its bark-covered stems, enable it to retain moisture.

9. *Pisonia aculeata* (Nyctaginaceae) Black Thorn.

A large, deciduous, trailing shrub which bears numerous branches set at right angles to the stem and to each other. It possesses dark-coloured bark, and is armed with numerous curved spines. The leaves are oval, and each is accompanied by two spines at its base. The leaves are leathery, but are shed in the dry season, so that the plant loses little water by transpiration during the periods of most severe drought. The flowers are tiny, and are borne in compact axillary and terminal cymes. The fruits bear sticky glands, and adhere to anything that touches them.

10. *Acacia farnesiana* (Leguminoseae—Mimosoideae) Sweet Briar.

This small shrubby tree deserves special notice, since at first sight it seems not to possess vegetative characteristics suited for its life in a dry habitat. The leaf consists of 4 to 8 side-appendages, each of which is made up of 10 to 20 tiny leaflets. It is said to be therefore, a "bipinnate compound leaf". During very dry weather most of the leaves drop off, thus effectively checking loss of water from the plant. The smallness of the leaflets, and their ability to close up or fold together at night (sleep movements), serve also as efficient means of minimising loss of moisture. The plant has, further, a very wide-spreading root system, so that it can obtain a very considerable supply of water from all but the driest substrata. The

flowers of the Sweet Briar are tiny, and are borne in dense yellow heads (which look like small fluffy balls. They are sweet smelling. The pods that succeed certain of the flowers in the head, are twisted, black and thick. They contain when green a sticky juice, which when extracted from them may be used to make ink by mixing it with green vitriol solution. The Sweet Briar probably originated in Anrerica. It is widely spread over the World, and seems to be able to live in almost any habitat. It has come to have such a world-wide distribution because of the very resistant and buoyant nature of the seed-pod which can (withstand unharmed, the action of sea water for many months.

11. *Pluchea odorata* (Compositae) Cure for All.

A common shrub with rough leaves which emit an aromatic odour when bruised. The plant, (except the older stems) is covered with a whitish down. The flower heads are heliotrope in colour. The seed posseses a hairy pappus and is wind borne.

12. *Chomelia fasciculata* (Rubiaceae) No common name.

A short stiff shrub with small woody spines and glossy, green, oval leaves, each of length ¼ to ½ inch, and borne in pairs on the stems. The flowers occur in small groups in the leaf-axils. They are small, 4-lobed, odorous and white. The fruit is a deep purple berry of length ⅜ inch. Several of them are borne at the ends of pendant slender stalks in groups in the axils of leaves.

13. *Clerodendron aculeatum* (Verbenaceae) Wild Coffee.

A shrubby plant which sometimes grows to a considerable size. Its leaves are bright-green, glossy and oval. The straight young branches are usually covered throughout their length with foliage, and the older branches possess strong spines which have been left by the leaf stalks when the leaves fall off. The narrow, foliate, tubular flowers are borne in great numbers in clusters all along the branches. They give place to brown woody, spherical fruits. The Wild Coffee is so-called because its leaves emit a coffee-like odour when bruised.

14. *Vinca rosea* (Apocynaceae) Periwinkle.

A little-branched, erect, (woody herb with pale green, oval leaves, and showy pink flowers, which are borne either singly or in groups of two or three in the leaf-axils. The corolla of the flower is flat, and is divided into 5 segments. It is funnel-shaped with a narrow tube. The fruit consists of two pod-like follicles joined at their bases. It is a "compound" or "aggregate" fruit. The Periwinkle is cultivated in gardens in Barbados. (See "Plants of Gardens"). It is probably an introduced plant, and has escaped from cultivation and gained access to other localities where it seems to thrive under almost adverse conditions of plant growth. *Vinca* has been spread everywhere in the tropics by man.

The plants described above are all common species in Barbados, and many of them will be mentioned again in subsequent pages. They do not include all the typical rock plants to be found in the Island, but they together make up the association of lithophytes as seen at Mt. Brevitor.

It might be advisable at this place to mention the names, and briefly to describe the features of a few other very common rocky-land plants occurring in certain regions of Barbados other than that just considered.

There is, at the very north of the Island, a desolate region of flat bare rocky land which borders the rugged sea cliffs of the coast of St. Lucy's Parish. The vegetation of this region is very scanty, and none but a few plants of xerophytic nature can grow there. The rugged, pitted and creviced surface of the rocks furnishes a very unfavourable habitat for plant life. Further, in addition to the lowness of the rainfall and the general absence of soily substratum, the wind in this region is persistent, and of considerable violence. Finally, those parts of the area immediately bordering the sea receive a certain amount of saline matter from the spray and salt wind which blow over them. At the edge of the cliffs the halophytic Seaside Samphire (*Sesuvium*), and occasionally the glaucous Wild Lavender (*Heliotropium currassavicum*) occur. Further inland, growing in shallow pockets of saline sandy debris, prostrate plants such as *Lippia reptans*, Duck Weed (*Pectis humifusa*), and Binding Grass (*Paspalum distichum*) may be seen. The true Lithophytes here include Seaside Sage (*Croton flavens*), and less abundantly, White Sage (*Lantana involucrata*), and Belly-Ache Bush (*Jatropha gossypifolia*). There occurs also another xerophyte of striking appearance and of wide distribution within this area of rocky land. It is the Prickly Pear (*Opuntia tuna*), and a description of its chief features will be found below. This plant seems to thrive in Barbados on almost bare rock, although it is well able to succeed in a dry, sandy substratum (instance its prevalence over extensive areas on the dry plains of the United States, Australia and other countries.)

In certain other rocky districts of Barbados, a few other species of lithopyhptic plants not yet mentioned are to be found. Of these, the herbaceous Laurel leaved Spurge (*Pedilanthus tithymaloides*); the tall columnar cactus (*Cephalocereus*): and the well-known Maypole or Century Plant (*Agave americana*) and other species, are the most interesting. They may be found growing in many dry rocky districts, such as the edge of the high coastal cliffs on the leeward side of St. Lucy's Parish, and the slopes of Chalky Mount in the Scotland District.

DESCRIPTION OF THE ADDITIONAL ROCKY-LAND PLANTS.

1. *Opuntia tuna* (Cactaceae) Prickly Pear.

The above-ground part of this plant is made up of a series of flat, thick, oval, green structures, which are attached in rows to a short, thick round stem. It grows to a height of anything up to 4 feet. The size of the mature oval segments is about 1 foot by 6 inches, by 2 inches thick. The segments are actually modified stems, and are able to function as leaves. They bear numerous clusters of long

yellow spines, at the bases of which cushions of tiny brittle hairs occur. The large flowers are arranged along the margins of the segments (or "phylloclades"). They give rise to red succulent berries, which contain numerous seeds. The berries also are furnished with cushions of brittle hairs. The succulent nature of the green segments, the presence of a thick smooth skin, which forms their outer covering, and the relative smallness of the area of the plant's surface are xerophytic features which partly account for the ability of the Prickly Pear to live in a dry habitat. The tenacious and much-branched root system of the plant enables it to obtain anchorage in, and to absorb water from a rocky substratum. *Opuntia* is probably disseminated by birds.

2. *Pedilanthus tithymaloides* (Euphorbiaceae) Laurel-leaved Spurge.

An erect, usually almost unbranched plant, with stems of uniform thickness of about ½ inch, and of height up to 2 feet. The leaves are thick, leathery oval, smooth, waxy, and green. They are arranged in two ranks and are inclined at an acute angle to the stem. These leaf-features are characteristically xerophytic. All parts of the plant contain a copious milky juice. The flowers are irregular in shape and red in colour. They resemble in appearance an upturned human foot in miniature—(hence the name). The fruit is a 3-chambered capsule.

3. *Cephalocereus* (*New Species*?) (Cactaceae) columnar cactus.

This cactus has erect greenish stems, which come off from a main stem and turn upwards, giving a candelabrum-like appearance to the plant. The height of the plant may be anything up to 8 feet. The stems are about 4 to 6 inches in diameter. They are leafless, but are furnished with numerous clusters of long spines situated at short intervals along ridges which run longitudinally down the stems. There are usually 10 such ridges and 10 shallow furrows. Flowers of large size are borne occasionally on the stems. The absence of leaves, and the cylindrical shape of the green parts of the plant, cause its surface area to be small compared with the total bulk of the plant. A tough covering also protects the surface. Hence, for its volume, the cactus loses little water by evaporation. Finally, the fact that the plant-tissues are succulent, enables the cactus to store up water, and thus to resist periods of extreme drought. Cacti are xerophytes of the most pronounced type. They show a very marked modification of plant structure which is entirely in keeping with their environment.

4. *Agave americana* (Amaryllidaceae) Maypole Bush or Century Plant.

This plant just prior to its flowering period, consists of numerous very stout, long, straight, fibrous, green leaves, arranged, rosette-like, round a short central stem-axis. The length of a mature leaf is between 3 and 4 feet. At the apex of each leaf, is a short spine, and the leaf-margins also are furnished with short spines set closely together. The tissue of the thick leaf is succulent, and the surface is protected by a tough skin covered with a layer of wax

which, however, is not very conspicuous. The root system is fibrous and wide-spreading. The *Agave* is a typical xerophytic plant, and is of slow growth. When the plant has reached a certain size it commences to put out its flowering axis, which consists of a quick-growing, green, stout, erect, stem-like structure. This reaches a height of some 10 to 20 feet, and is furnished with regularly arranged, green, pointed, leaf-like bracts. The inflorescence is a large terminal, branched panicle of numerous yellow flowers. Each flower is of length about 3 inches, and possesses honey glands, producing abundant nectar, which attracts humming birds and bees in large numbers. Frequently, in this and in certain closely-related species, many of the flowers are later replaced by "bulbils,"—that is, instead of the fruits developing small leafy seedling-like plants grow out from the inflorescence or from the main axis. Eventually the young plants so produced fall to the ground near to the parent, and here continue growth. When an *Agave* has finished flowering, the axis dies down. The leaves have previously commenced to wither, their stored contents having been used in producing nutriment for the reproductive organs. The whole plant thus comes to an end after a more or less extended period of growth (which may be as long as 10 years in Barbados, or even 100 in certain other countries) so that the plant is in a botanical sense an "annual" plant in that its life ends with the production of reproductive organs.
(N.B. In the name Century Plant is implied the long life period of *Agave*, and the name Maypole Bush may signify that it produces its tall flowering axis at the commencement of the wet season (in May), during which season many of the mature plants embark on their vegetative effort).

It is supposed by one authority that the well-known Barbados Maypole Bush described above is a species common only to Barbados. It has, therefore recently been named *Agave barbadense.*

5. *Agave vera.* This is very similar to the above in vegetative habit.

(3) PLANTS OF VERTICAL ROCKY WALLS

The peculiar gullies of the coralline region of Barbados have already been described in some detail. It was indicated in that description that a gully presents many different kinds of habitats to the growth of plants, and that, on the whole, the vegetation of gullies is luxurious because of the general moistness of the environment, and because of comparative freedom from interference by man.

For convenience of ecological description, a typical Barbados gully may be considered as consisting of five more or less distinct regions:—

(i) The vertical gully way (of height anything up to 150 feet).
(ii) The gully floor.
(iii) The sloping sides of the gully.
(iv) Stationary talus slopes.
(v) Caverns.

In many places in a gully, the sides are vertical from the very floor, and

frequently they overhang. In other places, the ground rises from the flat floor at a more or less steep angle, and meets the vertical wall at a point varying in height from the floor in the different parts of the gully. Occasionally the sloping ground between the floor and the wall is formed of loose material which has fallen down from the cliffs during weathering. This loose material constitutes the "talus" mentioned in the above list. The caverns are situated in the vertical gully wall usually in those places where the wall rises immediately from the floor.

It is intended to deal only with the plants of the gully *wall* in this place, because these plants furnish further examples of Barbados xerophytic lithophytes whose features differ somewhat from those of the lithophytes already considered.

(i) PLANTS OF THE VERTICAL WALLS OF GULLIES.

The wall of a gully is never smooth, but is pitted and pocketed into numerous cavities of all sizes. Many of these contain an appreciable amount of detritus mixed with decaying vegetable matter, and thus furnish habitats of various kinds for the growth of certain plants whose seeds chanced to have been transported thereto. The rock of a gully wall, being of coral limestone, is very porous and prone to weathering. The original structure of the coral is frequently discernible, and within many of its tubular passages the roots of plants of the gully wall are to be noticed growing into the moist interior of the rock in search of water.

The habitat in which the gully-wall plants grow is therefore peculiar, and we should naturally expect to find in the plants special features which account for the success of certain species of constant occurrence in such an environment. In the first place, gully-wall plants are placed under conditions where the water supply is not plentiful, and most of the larger plants derive the greater part of what moisture they obtain from the porous rock itself. No plants can thrive on the gully wall unless they possess well-marked xerophytic features. These will be expected to include such features as we have already learnt to connect with plants living under conditions of drought. Amongst them may be mentioned, (1) arrangements of leaves so as to produce mutual shading; (2) smallness of leaf-surface so as to reduce the area from which water may be lost by evaporation; (3) succulence or fleshiness of leaf-tissues for purposes of water storage; and (4) the presence of a thick epidermal covering accompanied perhaps by a layer of wax or of hairs or scales for purposes of protection. It is interesting to note here that certain gully-wall plants supplement the water supply which they derive from the support to which they are attached, with moisture obtained by means of "aerial roots" which sometimes reach down to the ground and penetrate the soil there.

In the second place, gully-wall plants possess root systems which securely fasten the plants against the rock face. It has already been mentioned how the roots of certain of these plants ramify into the channels and crevices of the rock. In many cases clinging roots are developed; these adhere to the bare rock and are usually adventitious, being produced from the stems of the plants and not from the main root system. Many gully-wall plants produce only roots of this kind. Such plants belong to the Monocotyledon class of flowering plants, and are represented chiefly by Orchids and species of Araceae.

Finally, no plant can become established on a vertical rocky wall unless its seeds are carried in the first instance to the places where the plant finally becomes fastened after the germination of its seeds. Further, unless those seeds germinate quickly and produce young roots capable of attaching the seedlings to the wall, there will be little chance of the species becoming represented in the vegetation of that particular habitat. The plants growing freely and naturally on Barbados gully-walls are indeed found to have means of dissemination of their seeds entirely in keeping with their mode of life. Many of them possess succulent fruits which are small enough to be eaten by birds,—the birds swallowing the seeds eventually to eject them again in places on the rocky face or in cavities and shelves of the gully wall. In certain cases, the fruits (or the seeds contained in them) are sticky, so that they adhere to beaks of the birds, and are carried by them to places on the gully wall where they are wiped off and left. Those gully-wall plants which do not possess succulent or sticky fruits, reproduce themselves by means of seeds which are small enough to be blown about by the wind. There is therefore some chance of the seeds of this kind of plant reaching clefts and cavities of the gully wall where they might germinate under conditions entirely favourable to them.

Let us now turn our attention to the actual plants that are found growing successfully on the vertical gully walls of Barbados, and enquire in each case into the degree of adaptation exhibited towards the environment in which the plant is placed.

Foremost amongst the plants that inhabit the rock-face are certain fairly large *xerophytic shrubs* to be named hereafter. The roots of these shrubs are found ramifying and bending in and out from pocket to pocket, and giving off rootlets that penetrate into the interior of the limestone. The shrubs grow most abundantly high up on the gully wall, and they possess long dangling air-roots which form a conspicuous feature especially when they are clothed with masses of other twining plants, which make use of any support in order to spread their leaves to the light. Frequently the dangling air-roots reach the floor of the gully where they penetrate into the soil, thus aiding in the supplying of water to the plants. From many of the larger pockets, *xerophytic* plants with a tuft-like habit grow out. A large-leaved fern is especially to be noticed along with other ferns, and also occasionally a Bromeliaceous plant with long leaves. Not so abundant are Orchids and Araceae. Next come *creeping succulent herbs,* which also root in the scanty soil in the cavities, and run from pocket to pocket or flatten themselves against the bare rock. Amongst them may be mentioned a creeping Cactus (*Cereus sp.*), which is occasionally seen high up on the gully wall, and also several Piperaceous plants which are abundant and conspicuous lower down the rocky face.

The kinds of plants thus far indicated are true "clinging" plants, and are found almost exclusively attached to supports. For this reason they are frequently termed "epiphytes." Certain of them are able to live on the branches of trees, as for instance, Orchids and Araceous plants. Orchids include perhaps, some of the most typical epiphytes known.

In addition to true epiphytes, certain *erect, succulent herbaceous plants,* and occasionally one or two typical *rock-plants* (such as those described previously), are to be seen growing out of the larger cavities of the gully wall, or perched up on ledges on its face.

(a) Epiphytic shrubs of the gully wall.

1. *Clusea rosea* (Guttiferae) Balsam Tree.

   A shrub with leathery leaves and conspicuous dangling roots. The leaves are oval and about 5 inches long by 3 inches broad. The flowers are large and pinkish; the crimson fruit is fleshy and very sticky, so that birds carry away the seeds and deposit them high up on the gully wall on ledges or in cavities.

2. *Ficus sp. (laurifolia) (Moraceae)* Bearded Fig.
   (See under "Shade trees"). Small specimens of this tree are occasionally seen growing on gully walls as epiphytes. The seeds are probably disseminated by birds (such as pigeons) that eat the small "figs."

3. *Sapium aucuparium* (Euphorbiaceae) Poison Tree.

   (See "Plants of the Forest"). The leaves of this epiphytic shrub are elliptical, and of length about 5 inches. They are leathery, and contain (as do also the stems) copious milky juice. The fruit is a 3-chambered capsule, the seeds of which are probably disseminated by birds.

(b) Tufted epiphytic plants of the gully wall.

1. *Campyloneurum latum* (Polypodiaceae—Filicineae) Hart's Tongue Fern.

   The leaves are simple, 1 to 3 feet long, 3 inches broad, with unindented margins, tapering bases, and roundish ends. They are stiff and leathery, and bear clusters of tiny sporangia dotted all over the under surfaces. The spores are dust-like, and are dispersed by wind, thus accounting for the presence of the fern in many cavities of the gully wall.

2. *Gymnogramme calamelanos* (Polypodiaceae—Filicineae) Silver-backed Fern.

   A fern common along rocky waysides.

3. *Bromelia pinguin* (Bromeliaceae) Pinguin.

   The leaves are narrow, of length 2 to 5 feet with spiny margins, and red sharp-pointed apices. They form a deep, cylindrical, water-tight cavity where they overlap at the base of the plant. The water which collects there is stored for the use of the plant, which absorbs it by certain hairs that grow out from the leaf surface. The roots have lost the power of absorption, and simply serve to hold the plant against the rocky wall. The flowers are borne in spikes. The fruit is a fleshy berry, and is probably dispersed by birds.

4. *Epidendrum ciliare* (Orchidaceae) Eyelash Orchid, Wild Lily, &c.

The leaves of this plant are thick and rigid. Their length is between 4 and 8 inches. They are attached at their base to thickened stem-structures (known as "pseudo-bulbs"), which serve as water-reservoirs. Frequently the leaves drop off from the pseudo-bulbs in very dry weather. The roots are of two sorts:—clinging roots (which hold the plants fast against the rock face, and which give out rootlets that absorb nutrient from the humus in the cavities), and dangling roots (which absorb moisture from the air by means of a special absorptive outer layer—the "velamen"). The flowers are sweet-scented, white and large. They are borne in a spreading raceme. The 'petals' (perianth members) are 2 inches long and quite narrow; their lips are fringed. The fruit is a dehiscent, elongated capsule, which contains a very great number of tiny dust-like seeds. These are easily disseminated by wind. *Epidendrum* flowers in gullies chiefly during the wet season

5. *Anthurium Nuegelii* (*Araceae*) Anthurium.

The leaves of this plant are elliptical, leathery, of length between 6 and 12 inches and of breadth 1 to 4 inches. The flowers are borne on a fleshy spike (of length usually about 3 inches) subtended by a narrow greenish bract, (of length equal to that of the spike), and carried on a stalk of length up to 12 inches. There is no true stem, the leaves being attached at their bases to a disc-like structure, from which numerous roots are given off and hold the plant tightly in position.

(c) Succulent epiphytic creepers of the gully-wall

1. *Peperomia obtusifolia* (Piperaceae)

A creeping plant with fairly succulent, leathery, elliptical leaves, which taper at the base into the leaf-stalk. The ends are rounded. The leaves are 1½ to 3 inches long, and 1 to 2 inches broad. The stems are pink in colour and branching. At each node numerous roots are given off. The flowers are minute, and are borne close together on a fleshy spike of length about 4 inches. The fruit is a small berry and is dispersed by birds.

2. *Peperomia acuminata* (*guadaloupensis*) (Piperaceae).

This plant is similar to the above, but has a rather well-marked forked method of branching. The leaves are about 2 inches long by about 1½ inches broad, and are obtusely pointed at the ends.

3. *Peperomia pelucia* (Piperaceae).

This grows in the damper and more shady parts of the gully wall. It is a delicate plant with translucent stems and leaves. The latter are acutely pointed, and seldom more than 1 inch long. They are thin and not very leathery.

4. *Cereus triangularis* (Cactaceae) Creeping Cactus.

The triangular green stems of this creeper are sparsely branched, and of width between 1 and 2 inches. They bear groups of 4 or 5 spines at intervals along their edges. The flowers, when produced, are very large and white. The fruit is egg-shaped and spiny. It is difficult to see how its seeds may be disseminated in Barbados, but probably birds are the agents of dispersal.

(d) Erect succulent plants of the gully wall.

These include two plants of importance commonly found growing on rocky land. They are *Bryophyllum calycinum,* (Wonder of the World), and *Pedilanthus tithymaloides* (Laurel Leaved Spurge).

(e) Erect plants with rough leaves of the gully wall.

These are also found in the rocky-land association. The chief of them are, *Lantana camara* (Sage); *L. involucrata* (White Sage); *Croton flavens* (Seaside Sage); *Cordia cylindristachya* (Black Sage); and also *Phyllanthus epiphyllanthus* (Sickle Leaved Spurge), whose leaves are really modified stems.

(N.B. The vegetation of the other regions of a typical gully, will be described in the next chapter when Mesophytes are considered).